ence Abstracts

Section A

Physics Abstracts

Published by
The Institution of
ctrical Engineers

Vol. 64 No. 759

March 1961

2583—4168

Physics Abstracts

Volume 64 MARCH 1961 Number 759

CONTENTS

MATHEMATICS Page 249

ASTROPHYSICS 249
Radioastronomy 255
Space research 257

PHYSICS 258
General 258
Gravitation. Relativity 259
Quantum theory 261
Statistical mechanics. Transfer processes 261
General mechanics 263
Mechanical measurements 263
Mechanics of fluids 263
Liquid state 265
Mechanics of gases 267
Shock waves 268
Gaseous state 269
Vacuum physics 269
Vibrations. Elastic waves 270
Acoustics 271
Instruments and measurements 273
Noise. Architectural acoustics 273
Optics. Photometry 273
Geometrical and instrumental optics. Spectroscopy 274
Physical optics 277
Colorimetry. Photography 279
Heat. Radiation 279
Change of state 281
Thermodynamics 281
Low-temperature physics 281
Liquid and solid helium 281
Superconductivity 282
Electricity. Electrical measurements and circuits 282
Electrostatics. Dielectrics 284
Current electricity. Electrokinetics 284
Ionization 284
Electric discharges 285
Plasma 286
Plasma oscillations 288
Electron emission. Electron beams 289
Ion emission. Ion beams 292
Particle accelerators 293
X-ray tubes and techniques 293
Magnetism 293
Electromagnetism. Magnetohydrodynamics 294
Electromagnetic waves and oscillations 295
Radiofrequency spectroscopy techniques 297

NUCLEAR PHYSICS Page 297
Apparatus. Particle detectors 297
Track visualization 299
Nuclear field theory 300
Elementary particles 304
Photons 304
X-rays —
Neutrinos 305
Electrons 305
Nucleons 305
Protons 306
Neutrons 307
Mesons 308
Hyperons 311
Deuterons 312
Tritons —
Alpha-particles 312
Cosmic rays 313
Nucleus 325
Energy levels 326
Nuclear decay. Radioactivity 327
Nuclear reactions 330
Due to photons 331
Due to electrons —
Due to nucleons 331
Due to protons 331
Due to neutrons 332
Due to mesons and hyperons 332
Due to deuterons 332
Due to alpha-particles 333
Due to other particles and nuclei 333
Nuclear fission 334
Thermonuclear reactions 335
Nuclear power studies 335

ATOMIC AND MOLECULAR PHYSICS 337
Atoms 337
Isotopes 339
Mesic atoms 339
Molecules 340

SOLID-STATE PHYSICS Page 345
Lattice mechanics 346
Thermal properties 347
Electron states 348
Defect properties 351
Diffusion 354
Colour centres 355
Radiation effects 355
Electrical properties of solids 356
Semiconductors 359
Semiconducting materials 360
Semiconductor devices 363
Photoconductivity 364
Thermoelectric properties 365
Dielectric properties 365
Optical properties of solids 366
Luminescence 369
Magnetic properties of solids 372
Magnetic resonances 375
Mechanical properties of solids 378
Structure of solids 383
Crystallography 383
Crystal lattice structures 385
Alloys. Metallurgy 388
Other solid forms 389
Surfaces. Films. Adsorption 389
Microstructure examination 390

PHYSICAL CHEMISTRY 391
Thermochemistry. Reactions 391
Electrochemistry 392
Photochemistry. Radiation chemistry 393
Dispersions. Colloids 393
Physical methods of chemical analysis —

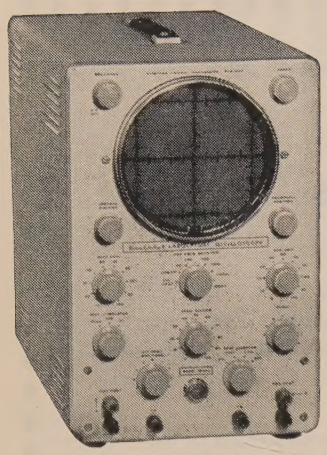
GEOPHYSICS 393
Atmosphere 393
Upper atmosphere. Ionosphere 394
Geomagnetism 395

BIOPHYSICS. PHYSIOLOGICAL PHYSICS 397
Hearing. Speech 397
Vision 398

TECHNIQUE. MATERIALS 400

The monthly Author Index, List of Journals, Errata and Notes follow immediately after the last page of abstracts
For subscription rates, additional details, etc., see page iii of cover

THE INSTITUTION OF ELECTRICAL ENGINEERS, SAVOY PLACE, LONDON W.C.2



Model O-12U
Oscilloscope

The kit-sets which give you the Best Possible Equipment at Absolutely Minimum Cost!

Heathkit
DAYSTROM

Examples are:—

5" FLAT-SCREEN OSCILLOSCOPE, Model O-12U
Laboratory instrument at utility 'scope price. Exceptionally wide-range time-base (10 c/s to 500 Kc/s) "Y" frequency range 3 c/s to over 5 Mc/s, sensitivity 10 mV RMS/cm. Electronically stabilised. Output for Wobbulator, Voltage Calibrator (1 volt pk. to pk. source). Instantaneous shift, drift free. Automatic lock-in synch. Rise time 0.08μ secs or less. "Z" modn. facilities 2 gold-plated printed circuit boards and pre-cut cable wiring harness greatly facilitate assembly **£34.15.0**

OSCILLOSCOPE TRACE DOUBLER, ELECTRONIC SWITCH, Model S-3U
This extremely useful, low priced device will extend the use of your single-beam oscilloscope for duties otherwise only in the province of the double-beam tube. In short, at a nominal cost, the Heathkit model S-3U will give you the advantages of a double (or other multiple) beam 'scope, while retaining all the advantages of your present single-beam instrument. Hitherto an electronic switch of this nature, permitting the simultaneous observation of two signals on the screen of a single-beam C.R.T. oscilloscope, has cost nearly as much as the 'scope itself. **£9.18.6**

PORTABLE 2½" SERVICE 'SCOPE, Model OS-1
The OS-1 uses a 2½" cathode ray tube and is a compact portable oscilloscope ideal for servicing and general laboratory work. Y amplifier sensitively 10m V/cm; response ± 3 dB 10 c/s-2.5 Mc/s. Time base 15 c/s–150Kc/s. Features include Int. Ext. and 50 c/s sync; Sine sweep; time base output for wobbulator; X amplifier socket; 1, 10 and 50 volt calibrator. Uses printed circuit board for consistency and ease of assembly Case 7⅜" × 4 11/16" × 12½" long. Weight only 10½ lb. **£18.19.6**

VALVE VOLTMETER, Model V-7A. Because of the accuracy, reliability and sheer value of the Model V-7A it is outselling all other VVM's. The precision and quality of its first-class components cannot be duplicated elsewhere at this price. Indication is by a large 4½" 200 μA meter clearly calibrated for all ranges. The voltage divider networks use 1% precision resistors. A gold-plated printed-circuit board simplifies the assembly, saves time and eliminates the possibility of wiring errors. It also ensures duplication of laboratory performance. This multi-function VVM measures A.C. Volts (RMS and pk. to pk.), D.C. Volts and Resistance. The 7, A.C. (RMS) and D.C. ranges are 1.5, 5, 15, 50, 150, 500 and 1500. The 7, A.C. pk. to pk. Voltage ranges are 4, 14, 40, 140, 400, 1400 and 4000. D.C. input impedance is 11 MΩ. Seven Ohm-meter ranges have multiplying factors of XI, X10, X100, X1000, X10 K, X100 K and X1 MΩ. Centre-scale resistance readings are 10, 100, 1000, 10 K Ohms, 1 MΩ and 10 MΩ. A centre-zero dB scale is provided also for measuring audio amplifier performance. Test leads, prods and battery are included in the kit. **£13.0.0**
PROBES: R.F. **£1.5.6,** H.V. (30 kV d.c.) **£2.7.6.**

Audio Signal Generator, AG-9U. A high class audio generator covering a frequency range of 10 c/s to 100 Kc/s. Distortion is less than 0.1% between 20 c/s and 20 Kc/s. Frequency is selected by the two decade switches times the multiplier. Output constant over the whole frequency range approx. ± 1 dB and is variable from 3 mV f.s.d. to 10 V f.s.d. Output monitored by a 4½" panel mounted 200 μA., m.c. meter **£19.3.0**

Direct Reading Capacitance Meter, CM-1U. Measures 100 μ μF full scale to .1 μF full scale with complete accuracy. 1% external standards provided for each of the four ranges **£14.10.0**

Multimeter, MM-1U. Measures wide range of voltage, current, resistance and dB in over 20 ranges. Sensitivity 20,000 ohms/volt D.C. and 5000 ohms/volt A.C. 0–1·5, 1500 volts A.C. and D.C. 0–150 μA, 15 A D.C. Resistance 0.2 ohms to 20 megohms. 4½" meter, 50 μA f.s.d. **£11.8.6**

Audio-Millivoltmeter, AV-3U. An A.C. valve millivoltmeter having 10 ranges for measurement from 10 mV f.s.d. to 300 V f.s.d. Frequency response 10 c/s to 400 Kc/s ± 1 dB. Input resistance not less than 1 megohm. 4½" meter with 200 μA movement **£13.18.6**

Audio Wattmeter, AW-1U. Power range 5 mW—50 W f.s.d. Frequency response 10 c/s to 250 Kc/s ± 1 dB. Internal load resistors 3, 8, 15 and 600 ohms ± 1% non-inductive and switch selected. Power ratings 25 watts continuous, 50 watts intermittent. 4½" meter with 200 μA movement **£13.18.6**

Power Supply Unit, MGP-1. Provides 3 D.C. outlets 250-300 V up to 90 mA., 170-220 V up to 30 mA, 150-200 V up to 10 mA and 6.3 V at 2.5 A A.C. **£4.9.0**

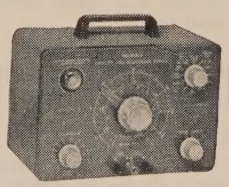
Decade Capacitance Box, DC-1. Precision 1% silver mica capacitors are used and switches are of the ceramic wafer type to ensure minimum loss. Three decades switches are used and cover a range of 100 pF to 0.111 μF in increments of 100 pF. **£5.18.6**

Resistance-Capacitance Bridge, C-3U. Resistance Capacitance Bridge measures capacitance up to 1000 μF and resistance up to 5 megohms. Also indicates leakage and provides a range of D.C. test voltages **£7.19.6**

Amplifier MA-12. A 10-12 watt high fidelity amplifier having extremely low distortion and wide frequency range. Generous auxiliary power supply provided .. **£9.19.6**

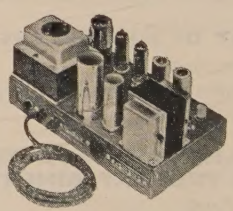
R.F. Signal Generator, RF-1U. Provides an accurate source of RF up to 100 Mc/s on fundamentals and 200 Mc/s on harmonics. Up to 100 mV output on all bands **£11.11.0**

AG-9U

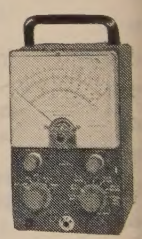


C-3U

S-3U



MA-12



V-7A

ALL AMERICAN KITS ARE NOW AVAILABLE (including Analogue Computers from £90 to £490)

Here are a few other examples:—

"Professional" 5" DC Oscilloscope, Model OP-1. Featuring a calibrated driven sweep with built-in triggering circuits, D.C. coupled vertical amplifier and a 5ADP2 flat-face CRT, the OP-1 offers professional performance at big savings **£95.0.0**

"General Research" 5" DC Oscilloscope, Model OR-1. An excellent read-out indicator in computer applications, as well as a versatile general service 'scope. Features identical D.C. coupled vertical amplifiers, 5ADP2 flat-face C.R.T, and transformer operated silicon diode power supply **£61.10.0**

"Q" Meter, Model QM-1. Measures inductance from 1 microhenry to 10 millihenrys, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf, ± 3 mmf vernier. Test coil for calibration and easy-to-follow instructions furnished **£28.10.0**

Harmonic Distortion Meter, Model HD-1. Measures harmonic distortion in amplifiers at frequencies between 20 and 20,000 CPS. Distortion ranges are 0-1, 3, 10, 30 and 100% full scale. Full scale voltage ranges are 0-1, 3, 10 and 30 V Features high input impedance and 1% precision resistors. Ideal for use with Heathkit model AG-9U Audio Generator **£25.2.0**

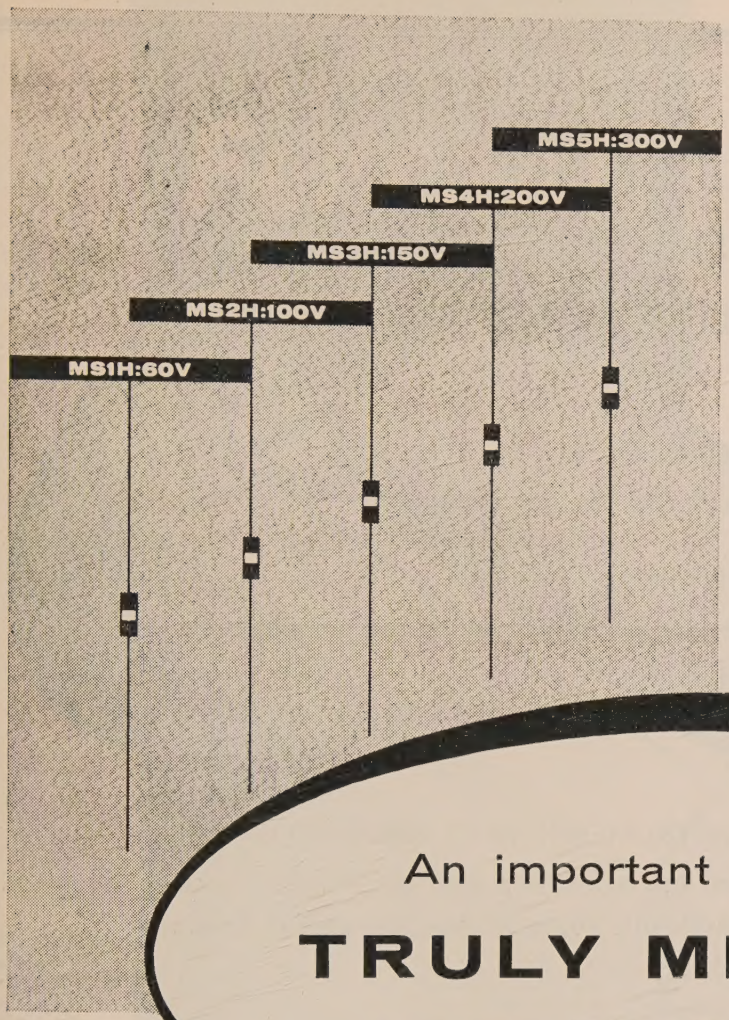
Impedance Bridge, Model IB-2A. Wheatstone bridge, capacity comparison bridge, Maxwell bridge and a Hay bridge in one compact unit. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mmf to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1 and storage factor (Q) from 0.1 to 1000. Built-in power supply, 1000 cycle generator and valve detector. Shpg. **£30.16.0**

We also recommend to you the American Heathkit **Transistorised Intercom Units** for use in the factory, office or home. The system consists of a master unit and up to 5 remote stations. .. .. XI-I Master Station **£14.3.0**; XIR-I Remote Station **£4.5.0**

N.B. Complete Catalogue of British HEATHKIT range and full details of any models gladly sent on request

DAYSTROM LTD

DEPT. SA3
GLOUCESTER



Ideal for Computer, Radar, Aircraft and other applications where miniaturisation is important

FIVE TYPES cover max. working voltages from 60V to 300V. Construction: hermetically sealed glass envelope with wire lead at each end.

An important AEI series of

TRULY MINIATURE

¼-amp SILICON DIODES

SPECIFICATION DETAILS

MINIATURE SIZE	Body only 7/64 in. dia., ¼ in. long, overall length 2½ in.
HIGH RATING	250 mA max. mean forward current
LOW LEAKAGE	1.0μA max. at 25°C at max. P.I.V.
LOW FORWARD VOLT DROP	1.0V max. at 200 mA
JUNCTION CAPACITANCE	5 pF max. at −1.0V
STORED CHARGE	20 m μ C max. (I_F=10 mA, V_R=−10V, R=1000Ω)

Please write for information Sheet EAD. 8012-1 and address enquiries to your nearest AEI Regional or District office, or

AEI

Associated Electrical Industries Limited

Electronic Apparatus Division

VALVE AND SEMICONDUCTOR SALES

LINCOLN, ENGLAND.

A5595

"SPEEDIVAC"

STAINLESS STEEL MERCURY VAPOUR DIFFUSION PUMPS

SPEEDS

from 10 to 1,500 litres per second.

VACUUM

better than 5 x 10⁻⁷ torr.

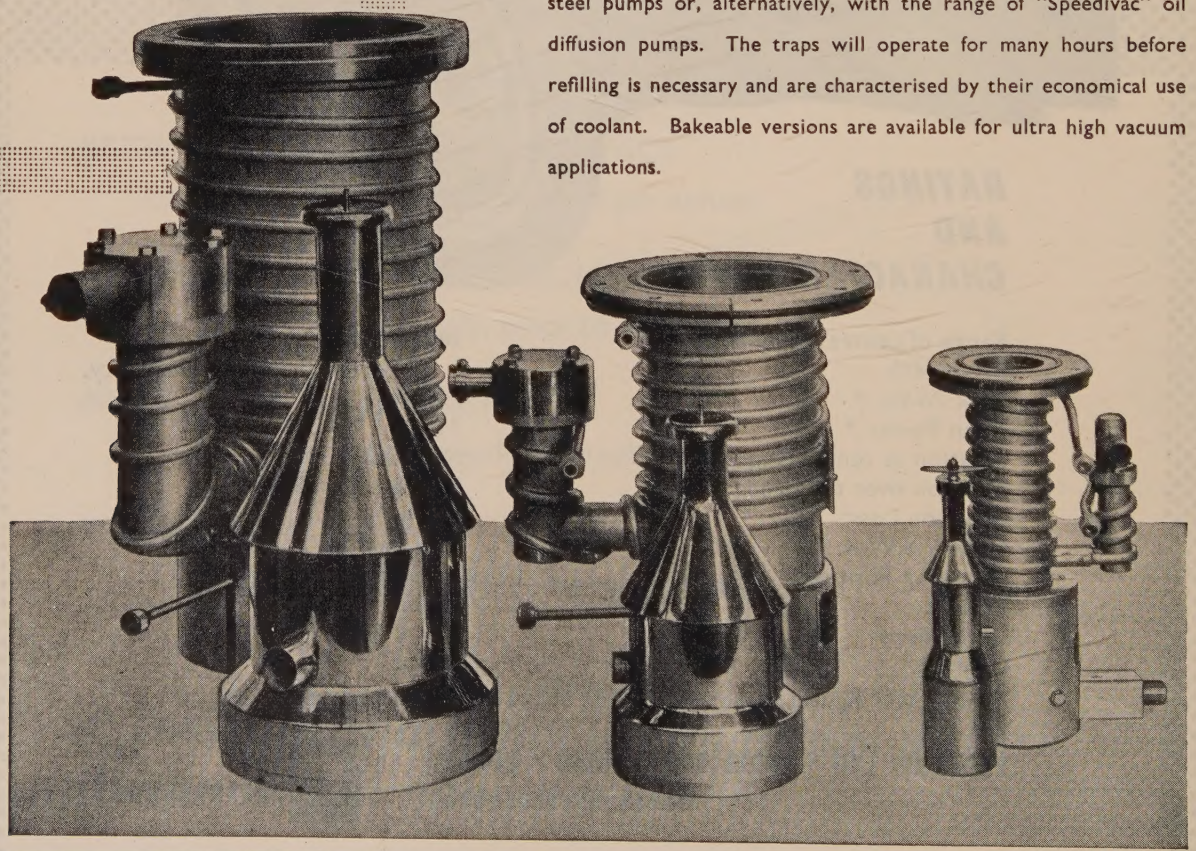
CRITICAL BACKING PRESSURES

0.5 torr (except 2M4A—backing pressure 30 torr).

The "Speedivac" range of mercury vapour diffusion pumps has been completely redesigned. The pumps are now constructed in corrosion resistant stainless steel with highly polished body interiors and jet assemblies. Pumps are available from 1″ to 9″ diameter bores together with a special 2¼″ pump, Model 2M4A which has a very high backing pressure performance.

STAINLESS STEEL VAPOUR TRAPS

A complete range of these traps is available for use with stainless steel pumps or, alternatively, with the range of "Speedivac" oil diffusion pumps. The traps will operate for many hours before refilling is necessary and are characterised by their economical use of coolant. Bakeable versions are available for ultra high vacuum applications.



EDWARDS HIGH VACUUM LTD | MANOR ROYAL | CRAWLEY Crawley 1500 | SUSSEX | ENGLAND

PHYSICS ABSTRACTS

Volume 64 MARCH 1961 Number 759

MATHEMATICS

SOLUTIONS OF $y''' + yy'' + \lambda(1 - y'^2) = 0$ AND THEIR PROPERTIES. See Abstr. 2774

2583 ACCUMULATING DIGITIZER SYSTEM.
T.H.Fields and R.W.Findley.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1312-17 (Dec., 1960).

A system is described for digital measurement and automatic recording of linear position. An adding—subtracting scaler is used to accumulate pulses generated by the digitizing element. Several of the major components are commercially available. The performance of the system as used for coordinate measurements on bubble chamber photographs is discussed.

2584 COMPOSITE VARIATIONAL PROBLEMS.
R.S.Ingarden.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 11, 687-9 (1959).

This note gives the method of solution of variational problems involving functionals of functionals. J.Goldstone

2585 A PRACTICAL MANUAL ON THE MONTE CARLO. METHOD FOR RANDOM WALK PROBLEMS.
E.D.Cashwell and C.J.Everett.
London/New York/Paris/Los Angeles: Pergamon Press (1959) x + 153 pp.

This volume is a first class text-book for those concerned with the practical translation of random walk problems into digital computer programmes, particularly those problems converning neutron and proton interactions with matter. Programmers with some experience will find that this book supplies the background necessary to complete their picture of the physical situations they are simulating. The art of programming a computer for this type of problem is to achieve substantial programme economy and methods of doing this are described, as are a number of useful subroutines. A brief résumé of some unclassified problems successfully treated by the method at Los Alamos is given in an appendix.
T.O.Jeffries

2586 A SIMPLE METHOD FOR IMPROVING THE ACCURACY OF CROSS-SPECTRAL DENSITY MEASUREMENTS. E.G.Gilbert.
Rev. sci. Instrum. (USA), Vol. 31, No. 9, 1014-15 (Sept., 1960).

The cross-spectral density (CSD) is defined as the complex Fourier transform of two random functions of time e_1 and e_2. In a recent instrument (Abstr. 4313 of 1959) the CSD is directly determined from e_1 and e_2 and errors can arise if the real component of the CSD is very much greater than the imaginary or vice versa. It is shown that these errors can be considerably reduced by making a second measurement with the inputs e_1 and e_2 interchanged.
W.T.Welford

ASTROPHYSICS

2587 COMBINED SCHMIDT TELESCOPES.
E.Vandekerkhove.
Observatory (GB), Vol. 80, 200-2 (Oct., 1960).

Description of a Schmidt camera convertible to a Cassegrain telescope, based on a 120 cm diameter F/1.75 primary mirror. The Schmidt aperture ratio is F/2.5 and the Cassegrain is F/5.5, converting to F/10 with a Barlow lens. W.T.Welford

2588 A CANADIAN-BUILT BIREFRINGENT MONOCHROMATOR. W.A.Knox.
J. Roy. Astron. Soc. Canada, Vol. 54, No. 6, 284-90 (Dec., 1960).

Constructional details are given of a privately owned and constructed 3-inch coronagraph incorporating a quartz polarizing monochromator of 7 plates and 8 polaroid filters. The monochromator has a working aperture of one inch, with a band-pass of 4 A at the working temperature of 79^0 F. Prominence detail may be satisfactorily recorded on either Eastman 103a E, or F film, or on Super Anscochrome daylight colour film with exposure times of 1/10 to 1/4 sec. For the much fainter coronal structure, exposures of up to 1 sec are needed. D.R.Barber

2589 ECLIPSE POLARIMETER.
E.P.Ney, W.F.Huch, R.W.Maas and R.B.Thorness.
Astrophys. J. (USA), Vol. 132, No. 3, 812-20 (Nov., 1960).

Equipment is described which was designed to measure the polarization in magnitude and direction and the absolute intensity of the coronal light from the sun during a total eclipse. The equipment scans a complete television raster comprising approximately 1000 raster points and measures the polarization at each of these positions once every 30 seconds. This complete experiment is carried out simultaneously at effective wavelengths of 4750 and 8300 A. In addition, background light-meters made a measurement of the intensity and average polarization of the light in an annular ring between 5 and 13 solar radii once every second. The equipment described was successfully operated during the total eclipse of the sun on October 2, 1959, at two sites in the Sahara Desert in French West Africa.

2590 AN INSTRUMENT FOR MEASURING ANGLES ON CURVED PHOTOGRAPHIC PLATES. J.Davis.
Jodrell Bank Ann. (GB), Vol. 1, No. 6, 274-9 (Nov., 1960).

An instrument for measuring directly great circle angles on the celestial sphere from the spherically, curved photographic plates used in meniscus Schmidt cameras is described. The errors arising in the instrument are discussed and their magnitudes given. The ultimate accuracy of this design of instrument is evaluated

2591 THE ELECTRONIC CAMERA, ITS INSTALLATION, AND RESULTS OBTAINED WITH THE 120-INCH REFLECTOR OF THE LICK OBSERVATORY.
A.Lallemand, M.Duchesne and M.F.Walker.
Publ. Astron. Soc. Pacific (USA), Vol. 72, 268-87 (Aug., 1960).

Tests are reported of the Lallemand electronic camera (Abstr. 6603 of 1958), made during Sept.-Oct. 1959 at the focus of the Lick Observatory 36 in. refractor, and the 120 in. coudé spectrograph. A detailed description is given of main and ancillary equipment used for the tests, together with an account of the principal results obtained from them. For direct photography at the 36 in. telescope, the

limiting stellar magnitude obtained with a 45 min. exposure was $18^m.0$, using a narrow-cut Schott OG 1 filter. Loss of contrast caused by enhanced sky-background was negligible for exposures up to 72 min. The spectrographic tests with the 120 in. instrument showed that the electronic camera can secure adequate records of spectra so faint that conventional methods would fail to yield a satisfactory result. The present equipment may be used, without further modification, for spectrographic observations of stars down to $14^m.0$ (pg). D.R.Barber

2592 ON A NEW APPROACH TO COSMOLOGY. II. THE PROBLEM OF LOCAL GRAVITATION. .
H.Nariai and Y.Ueno.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 305-27 (Feb., 1960).

For Pt I, see Abstr. 14379 of 1960. A study is made of the problem of the local gravitational field due to such a large-scale aggregation of matter that the effect of the cosmic expansion cannot be ignored. The formalism provides a basis for treating the dynamical motion of galaxies within the Supergalaxy, together with the re-examination of the velocity–distance relation of galaxies.

2593 INTERSTELLAR MATTER AT LARGE DISTANCES FROM THE GALACTIC PLANE. G.Münch and H.Zirin.
Astrophys. J. (USA), Vol. 133, No. 1, 11-28 (Jan., 1961).

The interstellar gas at large distances z from the galactic plane is studied by the absorption lines it produces on the spectrum of distant stars off the Milky Way. From the statistics of multiple lines in various ranges of z, it is shown that some gas clouds probably exist at z = 1 kpc. The number of clouds observed in $0.5 < z < 1$ kpc has been found to be larger than would be expected from the known distribution of their velocity components in the galactic plane. The apparent asymmetry in the distribution of high-velocity clouds is explained as the result of decreased chances of collisions in the z-direction and also in terms of an intrinsic anisotropy in the mechanism accelerating the clouds. The typical time required for the clouds to reach their actual probable height from z = 0 is evaluated to be 40×10^6 years. From the line intensities and by assuming cosmic abundance of the elements, a relation between the linear dimensions and the densities of the clouds is established. Irrespective of whether the clouds are H I or H II regions, it is found that their continued existence for 40×10^6 years requires the operation of a process preventing them from expanding. The physical conditions prevailing in a galactic halo or corona exerting pressure on the clouds are next analyzed. It is shown how the observations rule out a halo with an electron temperature T_e around 10^4 °K. A corona with $T_e = 10^6$ °K, as postulated by Spitzer, on the other hand, is found admissible, provided that the high-velocity clouds at high z are H II regions. The large energy input by conduction from the corona may be balanced by radiative losses only at about $T_e = 10^4$ °K. Next the ionization equilibrium in the clouds is briefly discussed, and it is suggested that the anomalous abundance ratio Na/Ca observed in interstellar space is the result of using an unrealistic mean stellar radiation field in the photo-ionization computations. In this context, the results of a calculation of the ionization equilibrium of aluminium is presented. It is shown that the Al I line at λ 3964 should have a strength about one-twentieth that of Ca I λ 4226. In a final section the possible mechanisms by means of which interstellar clouds may be accelerated are discussed. It is shown how the operation of the Oort–Spitzer process requires a ratio between the total amounts of ionized and neutral interstellar matter much larger than is observed. The relevance of magnetic fields in accelerating small masses of ionized field-free materials is thereby emphasized.

2594 THE EFFECT OF ORIENTATION OF NON-SPHERICAL PARTICLES ON INTERSTELLAR EXTINCTION.
J.M.Greenberg and A.S.Meltzer.
Astrophys. J. (USA), Vol. 132, No. 3, 667-71 (Nov., 1960).

An investigation is made of the effect of orientation of non-spherical particles on the interstellar reddening-curve. An approximate calculation of the scattering by non-spherical particles is applied to a model dust cloud. It is predicted that there should be significantly greater extinction in the ultraviolet relative to the visible for stars viewed along magnetic-field lines as compared with those viewed across. A preliminary comparison with existing data indicates qualitative confirmation of the prediction.

2595 THE SIZES OF INTERSTELLAR GRAINS.
J.M.Greenberg.
Astrophys. J. (USA), Vol. 132, No. 3, 672-6 (Nov., 1960).

A comparison is made between the effect of orientation of Platt particles and of classical particles on the wavelength dependence of extinction. It is shown that the classical particles produce a significantly larger variation with orientation than do the Platt particles.

2596 IONIZATION FRONTS IN INTERSTELLAR GAS AND THE EXPANSION OF H II REGIONS. G.A.Goldsworthy
Phil. Trans A (GB), Vol. 253, 277-300 (Feb. 9, 1961).

The gas dynamical effects of an expanding nearly fully ionized hydrogen region (H II region), which is associated with the formation of O and B stars, are investigated The radiation from the hot star is absorbed by the surrounding interstellar gas (mainly neutral hydrogen) and leads to its ionization. Previous analyses have disregarded the internal motions set up in expanding H II regions. Similarity solutions of the equations of motion are presented for spherical and cylindrical problems, thus enabling the effects of groups of stars as well as individual stars to be discussed. For similarity to be applicable the initial density variations of the undisturbed neutral gas have to be $1/r^{3/2}$ in the spherical case and like $1/r$ in the cylindrical case. This does not, however, limit their use in describing the general picture of events for any other given density distribution. Recombination of the ions and electrons and subsequent re-ionization by radiation within the H II region is allowed for; cooling processes such as that due to the excitation of O^+ ions are also taken into account. It is shown that the temperature of the ionized gas in the H II region is approximately uniform even though the region as whole is expanding. Rates of expansion are calculated and it is also determined whether a shock propagates ahead of the ionized gas. In particular for rates of expansion less than about 20 km/s a shock wave occurs ahead, but for speeds greater than about 20 km/s, which would occur in the initial motion the rate of expansion of the ionized gas is too great and an "isothermal" shock occurs within the H II region. The boundary between the ionized and neutral gases can be regarded as a discontinuity and is termed an ionization front. The propagation of such fronts and accompanying shocks is considered. The lack of uniqueness, which occurs in the present paper, is removed when the results are combined with Axford's work (see following abstract).

2597 IONIZATION FRONTS IN INTERSTELLAR GAS: THE STRUCTURE OF IONIZATION FRONTS. W.I.Axford.
Phil. Trans A (GB), Vol. 253, 301-33 (Feb. 9, 1961).

A complete analysis of the structures of all types of ionization front is given, together with computed examples. It is shown that the solutions given by Goldsworthy for the propagation of ionization fronts, considered as discontinuities, can be made unique, and the unique solutions are given for the case of cylindrical symmetry. Ionization fronts of all types are shown to be possible, depending on the density of the ionized gas and the spectral type of the radiation. In particular strong D-type and weak R-type ionization fronts (corresponding to strong deflagrations and weak detonations, respectively, in combustion theory) prove to be of importance. The existence of these discontinuities conflicts with the Chapman–Jouguet hypothesis and the reasons for this behaviour are examined in detail. It is concluded that the most important condition for waves of this type to occur is that strong cooling effects should be present, which allow the stagnation enthalpy of the flow to have a maximum before decreasing to an equilibrium value at the rear of the wave. It is suggested that this may be of significance in the theory of other gas-dynamic discontinuities, and in determining the validity of the Chapman–Jouguet hypothesis in general.

2598 INTERPLANETARY IONIZATION BY SOLAR EXTREME ULTRAVIOLET RADIATION. H.Hinteregger.
Astrophys. J. (USA), Vol. 132, No. 3, 801-11 (Nov., 1960).

From recent rocket monochromator measurements of solar photon fluxes, $\Phi(\lambda)$, between 1300 and 60 A around 200 km, the fluxes Φ_0 characteristic of the upper F_2-region and interplanetary space near the earth are estimated by assuming some reasonable spectral attenuation factors Φ/Φ_0 due to the atmosphere absorption above the point of observation. Ionization rates in terms of $\sigma_j\Phi_0$ are estimated for H, O, N, and N_2. The estimated total ionization rate for the hydrogen atom of about 5×10^{-7} per second implies a fractional ionization of at least 99.9% for total hydrogen particle number densities of less than about $500/cm^3$.

2599 ORIGIN AND NATURE OF LUNAR SURFACE FEATURES. J.J.Gilvarry.
Nature (GB), Vol. 188, 886-91 (Dec. 10, 1960).

An analogous process to that responsible for the terrestrial atmosphere and hydrosphere is postulated to explain the initial presence of these same features on the moon. These were formed by exudation from the lunar interior in a time short when compared with their corresponding lifetimes. Taking various possible atmospheric constituents, it is shown that the lifetime of H_2O will be by far the longest for escape temperatures in excess of 10^3 °K, viz. $\sim 4.5 \times 10^8$ yr, and so comparable with the accepted age of the moon. Baldwin's data (1949), correlating diameter with depth for the various classes of lunar craters, suggest that the lunar highlandss consist of harder rocks than those of the "maria". The latter are more probably sedimentary (not basaltic, as required by the volcanic hypothesis). Evidence for the formation of craters by the submarine impact of meteorites when the "maria" were covered by the primitive hydrosphere is discussed, as also is the evidence for existence in the lunar hydrosphere of primitive (possibly algal) forms of life initiated by synthesis of complex organic molecules as a result of the action of solar u.v. radiation, and lunar electrical discharges. The inferred presence of C_2, in particular, will account for Kozyrev's recent observation of the Swan bands as resulting from the sublimation of crater material on heating by meteoritic impact. Such an explanation is more satisfactory than one based on purely volcanic action for which no direct evidence exists. 44 refs.

D.R.Barber

2600 ESCAPE OF PLANETARY ATMOSPHERES. I. ESCAPE LAYER. J.J.Gilvarry.
Phys. of Fluids (USA), Vol. 4, No. 1, 2-7 (Jan., 1961).

The critical layer for thermal escape of a planetary atmosphere is treated on a model in which an isothermal exosphere at high temperature merges within a narrow zone (the endopause) of varying temperature into the remainder (the endosphere) of the atmosphere, isothermal above the level at which mixing stops. Only one major constituent of the atmosphere is considered, and constant scale heights are assumed for the exosphere and for the endosphere above the level at which diffusion sets in. The height of the escape layer is evaluated analytically by considering the pressure balance at the base of the exosphere. The result permits one to determine explicitly the amount (the concentration or the number of molecules above unit area) of a minor constituent at the critical level, taking thermal diffusion across the endopause into account. The predicted height of the escape layer as determined from a model atmosphere of Nicolet (1957) shows essential agreement with the height inferred directly by means of the number density, scale height, and collision diameter.

2601 ESCAPE OF PLANETARY ATMOSPHERES. II. LIFETIMES OF MINOR CONSTITUENTS. J.J.Gilvarry.
Phys. of Fluids (USA), Vol. 4, No. 1, 8-12 (Jan., 1961).

It is shown that the essential parameter determining the escape rate is the ratio to the exospheric scale height of the radius of the escape layer as a measured from the planet's centre. The result of the analysis is to replace Spitzer's parameter B by a modified value A_i for the lifetime of the i-th minor constituent. This revision properly takes into account the effect on a minor constituent's lifetime of the difference in temperature between the escape layer and the endosphere. Correctly, the ratio of the minor constituent's molecular weight to a mean value for the atmosphere enters into A_i as a factor; the need for this particular correction to B has been pointed out previously by Nicolet (1957) and by Bates and McDowell (1957). Numerically, it is found that A_i and B do not differ drastically for the case of He^4 in the earth's atmosphere. Computations by Spitzer (1952) and by Urey (1959) for the loss of He^4 from the earth are brought into agreement by revision of the data employed by the former, and thus the discrepancy between corresponding temperatures implied for the escape layer is removed.

2602 DISTRIBUTION OF DENSITY IN A PLANETARY EXOSPHERE. II. E.J.Öpik and S.F.Singer.
Phys. of Fluids (USA), Vol. 4, No. 2, 221-33 (Feb., 1961).

For Pt I, see Abstr. 835 of 1960. In an isolated neutral exosphere three components can be distinguished: (1) elliptic-ballistic; (2) hyperbolic-ballistic; (3) bound-elliptic. Component (2) forms the escape flux which cannot be defined simply. The velocity distribution of all components is calculated as a function of altitude in the exosphere; one can thereby assess the importance of the bound orbits. Even with the bound orbits completely filled, according to detailed balancing, the velocity distribution is non-Maxwellian; hence the barometric formula cannot be applied to determine the distribution of density. The absence of a Maxwellian distribution is shown to exist at all levels above the reference level (base of the exosphere) and the effective kinetic temperature of the gas is shown to decrease with altitude. The "base of the exosphere" forms the dividing level between the barosphere and exosphere; its conventional definition has been re-examined and it is redefined to correspond to the level from which one-half of the escaping molecules may escape without suffering any collisions. Numerical results for all components versus altitude are given for neutral hydrogen and oxygen, applicable to the terrestrial exosphere. The contribution of bound orbits is estimated and shown to be minor at all levels. Bound orbits may be important for the exospheres of the outer planets. The interplanetary gas may be considered as an extension of the solar atmosphere; however, caution must be exercised in treating it as an exosphere.

2603 THE THERMAL BUDGET OF THE PLANET MERCURY. J.C.G.Walker.
Astrophys. J. (USA), Vol. 133, No. 1, 274-80 (Jan., 1961).

Assuming that the interior of Mercury is in thermal steady state, that the specific rate of radioactive heat production in the planet is equal to that in chondritic meteorites, and that the thermal conductivity equals 1.33 cal deg^{-1} cm^{-1} min^{-1}, the surface temperatures on Mercury range from 621°K at the sub-solar point (at mean distance from the sun) to 28°K at the antisolar point. These temperatures are relatively insensitive to changes in conductivity and rate of heat production.

SURFACE TEMPERATURE OF VENUS FROM MICROWAVE DATA. See Abstr. 2659

2604 THE NATURE OF THE GRAINS IN THE TAILS OF COMETS 1956h AND 1957d. W.Liller.
Astrophys. J. (USA), Vol. 132, No. 3, 867-82 (Nov., 1960).

Photoelectric spectrophotometric observations of the tails of Comets 1956h (Arend-Roland) and 1957d (Mrkos) show that, at a solar distance of $\sim \frac{2}{3}$ a.u., most of the radiation between λ 3400 and λ 6400 was of a continuous nature and redder than sunlight. Comparison of the observed energy distributions with theoretical curves of light-scattering by small particles strongly suggests that spherules of iron in the tails with average diameters of 0.6 μ and masses of 8×10^{-13} g produced this radiation. Considerations of the brightnesses of the comet tails permit estimates to be made of the total masses of these particles in each of the comets.

2605 THE MOTION OF THE ENKE-BAKLUND COMET FOR THE YEARS 1898-1911 AND A NEW DETERMINATION OF THE MASS OF MERCURY. S.G.Makover and N.A.Bokhan.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 3, 552-4 (Sept. 21, 1960). In Russian.

Data for five appearances of the comet in the period 1898-1911 were re-examined in the light of modern knowledge and used to compute the mass of Mercury. A weighted mean of the value obtained and the value computed by S.G.Makover [Trudy Instituta teoreticheskoi astronomi, Akad. Nauk SSSR, Vol. 4 (1954) and Vol. 6 (1956)] gives the mass as 1/(5 980 000 ± 170 000) solar masses. [English translation in: Soviet Physics—Doklady (USA)].

G.A.Chisnall

2606 VARIABLE BRIGHTNESS OF COMET BURNHAM (1959k) AND AURORAL ACTIVITY, 1960 APRIL 27-30. D.R.Barber.
Observatory (GB), Vol. 80, 198-9 (Oct., 1960).

A short series of photographic magnitudes of the comet obtained during April 1960 at the Norman Lockyer Observatory Sidmouth, reveal two well-marked changes of the integrated brightness of the cometary head between April 27.13 and 27.99, namely, a sudden decrease of $0^m.6$, and a subsequent increase of $0^m.4$. These changes, which were confirmed by corresponding changes in the comet's visual brightness of $1^m.2$, and $0^m.3$, respectively, appear to demonstrate the interaction of solar corpuscular streams with the gaseous envelope of the cometary head. Diffuse auroral glows were seen at Sidmouth on the night of April 27-28, and again on the morning of April 30. In the late evening of the same day, a moderately bright display was observed with some ray activity. It thus appears likely that the changes of brightness of Comet Burnham were caused by the same stream of solar particles as that responsible for the auroral activity.

D.R.Barber

2607 THE RECORD IN THE METEORITES. III. ON THE DEVELOPMENT OF METEORITES IN ASTEROIDAL BODIES. R.A.Fish, G.G.Goles and E.Anders.
Astrophys. J. (USA), Vol. 132, No. 1, 243-58 (July, 1960).

It is proposed that the meteorites originated in planetesimals of asteroidal dimensions, heated by some transient internal energy source, such as extinct radioactivity. The usual objections to an origin in small bodies are examined and are shown to be unfounded. It is shown that segregation of metal and silicate phases and mineral differentiation by crystal settling will take place in reasonable time scales even in small bodies. Evidence concerning the occurrence of diamonds in meteorites is critically examined and is found to be inconsistent with an origin in large bodies. Instead, it is regarded that diamonds were formed as a metastable phase by decomposition of cohenite (Fe_3C), under localized stresses, or else upon impact with the earth (as proposed by Nininger). A detailed study of the thermal evolution of internally heated planetesimals is undertaken with a view to discovering spontaneous processes that might have led to the development of the meteorites. After the onset of melting, the equilibrium configuration of the planetesimal will comprise an inner core of metal and an outer core of silicate; a mantle of chondritic composition, compacted by sintering; and an unconsolidated surface layer. The expected properties of material from each of these strata agrees well with those of the known classes of meteorites. Further temperature rise in the planetesimal will result in quasi-volcanic eruptions due to evolution of gases and vapours (e.g. elemental sulphur, carbon monoxide, silicon monosulphide) from the interior. This quasi-volcanic activity will cause extensive recycling of material and can lead to the development of many detailed features of the meteorites. New evidence is presented to show that the capillary veins in stone meteorites were produced by momentary action of hot, sulphur-containing gases, in accord with the proposed model. Another consequence of the model is the operation of a cyclic process that will deplete the chondritic mantle in some chalcophile elements, such as In, Tl, Pb, and Bi, and might account for the discrepancies between the observed and predicted abundances of these elements in chondrites. Possible energy sources are critically examined. Only extinct radioactivity seems to meet all requirements. In order for this source to have been important, it is necessary for the parent bodies of the meteorites to have accreted within 6-7 million years after nucleogenesis, in which case 7.3×10^5 year Al^{26} could have provided an adequate source of heat, or an uncharacterized nuclide with a half-life if 10^5-10^6 years exists and was present in the early solar system.

2608 ISOTOPIC COMPOSITION OF SILVER IN AN IRON METEORITE. V.Rama Murthy.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 539-41 (Dec. 15, 1960).

The possibility is examined that the silver content of an iron meteorite may be enriched in Ag^{107} as a result of the decay of an extinct radionuclide Pd^{107} if the metal phase of the meteorite is formed within a few half-lives of Pd^{107} (7.5×10^6 years) after nucleosynthesis ends. A measurement of the Ag^{107}/Ag^{109} ratio was made for silver extracted from the troilite of the Toluca meteorite and compared with that in reagent $AgNO_3$. The ratio was 2% greater in the case of meteorite silver. Assuming that the enrichment is due to the decay of Pd^{107}, estimates are made of the time interval between nucleosynthesis and the formation of iron meteorites on the basis of "single event" and "continuous" models of nucleosynthesis.

R.E.Meads

2609 SCATTERING OF ELECTROMAGNETIC WAVES ON ABSORBING AND ON DIELECTRIC SPHERICAL INDIVIDUAL PARTICLES AND ON MIXTURES OF SUCH PARTICLES. R.H.Giese.
Z. Astrophys. (Germany), Vol. 51, No. 2, 119-47 (1961). In German.

In order to consider problems of the zodiacal light, scattering functions of spherical iron particles ($m = 1.27 - 1.37\,i$; $\alpha = 1\ (1)\ 40$), of absorbing particles ($m = 1.33 - m_2 i$; $m_2 = 0.05, 0.5, 1.33, 3$; $\alpha = 1, 5, 10, 15$), and of dielectric particles ($m = 1.33$; $m = 1.55$; $\alpha = 1\ (1)\ 40$) were calculated at $\Delta\theta = 2^0$ interval where, m = refractive index, α = circumference/wavelength, θ = scattering angle against the direction of incident light. The scattered light of metallic spheres has positive polarization. For very small particles, totally reflecting particles, and big spheres the calculated Mie scattering functions agree with the functions calculated for these cases by other methods. Using the calculated scattering functions the solar light pressure on interplanetary particles of Ni and H_2O is discussed. The scattering functions of mixtures of particles with different sizes and of different materials (Fe, H_2O, SiO_2) were calculated. Integrations along the line of sight give for the differe mixtures maximum polarizations of the zodiacal light from $|p| < 5$ up to $p \cong 47\%$. No calculated mixture of dust particles alone (with electrons) presents a run of polarization with elongation as observ in the zodiacal light by Elsässer.

2610 TERRESTRIAL AND COMETARY MANIFESTATIONS CORPUSCULAR SOLAR ENERGY. V.Tcherednitchenk
Bull. Soc. Roy. Sci. Liege (Belgium), Vol. 29, No. 9-10, 254-7 (Sept.-Oct., 1960). In French.

Attention is drawn to the importance of the flux of solar corpuscles in the understanding of certain phenomena which take place either in the earth's atmosphere or in cometary atmospheres. Th article is a brief resumé of the results of many parallel investigations which will be published in greater detail elsewhere.

A.Boksenber

2611 THE HYDRODYNAMIC THEORY OF SOLAR CORPUSCULAR RADIATION AND STELLAR WINDS.
E.N.Parker.
Astrophys. J. (USA), Vol. 132, No. 3, 821-6 (Nov., 1960).

From the conventional application of the static barometric law to the density of the solar corona, observed out to 20 R⊙ at sunspo minimum, it is shown that the corona would be so hot at 20 R⊙ tha could not be static but must expand. Thus the temperature in the outer corona cannot be deduced from the density distribution by using the static barometric law. Allowing for the possibility of ex pansion, the solution of the stationary, spherically symmetric, hyd dynamic equation for a uniform coronal temperature of 1.22×10^6 fits the observed coronal density precisely out to 14 R⊙, indicating an expansion velocity of the order of 300 km/sec at large radial distances. An extensive investigation is made of the singular mat matical properties of the solutions of the stationary, spherically symmetric, non-linear hydrodynamic equation for the polytrope la p a N^2. Continuous solutions $\psi[(\psi_0)_c, a, \lambda; \xi]$ are shown to exist which go from low velocity in a strong gravitational field at the ba of the corona out to infinity with the necessary boundary condition that $p(\infty) = 0$. These solutions yield supersonic velocities of expa sion. The mathematical theory allows the calculation of the upper and lower bounds on the velocity of expansion of the solar corona (the solar wind) into interplanetary space. At solar minimum the velocity of expansion may be only 300 km/sec, with densities as lo as $20/cm^3$ at the orbit of earth. The quiet-day solar wind during t years of solar activity is >500 km/sec. The solar wind is obvious what has heretofore been termed the "solar corpuscular radiation" to which quiet-day velocities and densities of 500 km/sec and $10^2/cm^3$ have been assigned on the basis of a number of independe observational analyses. All main-sequence stars later than class F are shown to possess stellar winds, in analogy with the solar wi so that the phenomenon is of widespread importance in the mass balance of the Galaxy, as well as in the early evolution of most sta An appendix outlines the theory of hydromagnetic heating of the so corona, and indicates that the ion thermal velocity in a stellar atm sphere, in which hydromagnetic heating is dominant, should be of t same order as the hydromagnetic wave velocity. This prediction i in agreement with the observed solar coronal temperatures.

2612 THE SOLAR SPECTRUM FROM 2635 TO 2085 A. H.H.Malitson, J.D.Purcell, R.Tousey and C.E.Moore.
Astrophys. J. (USA), Vol. 132, No. 3, 746-66 (Nov., 1960).

Solar ultraviolet spectra obtained from rockets flown on December 15, 1952, February 21, 1955, and June 4, 1956, are presented and analysed over the wavelength range 2635-2085 A, together with an absolute spectral intensity distribution curve. In all, 538 absorption features were observed, and 949 atomic lines are listed as contributing to the observed spectrum.

2613 OBSERVATIONS OF SUNSPOTS IN THE SECOND HAL OF THE YEAR 1957. F.Yilmaz.
Rev. Fac. Sci. Univ. Istanbul C (Turkey), Vol. 24, No. 3-4, 206-16 (July-Oct., 1959). In French.

A continuation of the results of routine observations made at Istanbul University Observatory during 1957. Those for the first months of the year were reported previously (Abstr. 8501 of 1960). Tabulated data appear for 366 spot groups observed on 156 days.

D.R.Bart

2614 SIMULTANEOUS OBSERVATIONS OF MAGNETIC AND VELOCITY FIELDS IN A LARGE GROUP OF SUNSPOTS. M.Semel.
C.R.Acad. Sci. (France), Vol. 251, No. 14, 1346-8 (Oct. 3, 1960). In French.

The observations were made at the Pic du Midi Observatory with the 9 m spectrograph to which was attached polarizing apparatus for measuring the Zeeman components of the Fe I line at 6302.5 A. Results based on spectrophotometric measures in the spectrum of a large bipolar spot photographed on 28 November 1959 are described and discussed. A chart depicting the detailed distribution of magnetic polarity, and sightline velocity is reproduced. D.R.Barber

2615 INTERPRETATION OF THE POLARIZATION OF [MONOCHROMATIC] LIGHT FROM SUNSPOTS. J.L.Leroy.
C.R.Acad. Sci. (France), Vol. 251, No. 17, 1720-2 (Oct. 24, 1960). In French.

It is suggested that the observed polarization of the photospheric light from sunspots is caused by Zeeman effect. The plane polarization associated with the line spectrum of an active spot originates from the Zeeman separation of the line components in the transverse magnetic field of the spot. Of the three equal Zeeman components observed in a direction perpendicular to the field, those for which the plane of vibration is along the field are less absorbed than that for which the plane of vibration is at right angles to the magnetic field. Thus, a spot field of about 50 G will suffice to produce a measurable plane polarization of the spectral line. A graphical representation of the variation of the fractional polarization as a function of the strength of the sunspot field is included. For field-strengths (at right angles to the line of sight) ranging from 50 to 2000 G the observed proportion of plane-polarized light is found to vary between 10^{-5} and 10^{-2}. D.R.Barber

2616 AREAS AND POSITIONS OF CALCIUM FLOCCULI DURING 1959 ACCORDING TO OBSERVATIONS MADE WITH THE SOLAR TOWER [SPECTROHELIOGRAPH] AT ARCETRI. G.Godoli.
Mem. Soc. Astron. Ital., Vol. 31, No. 2-3, 317-27 (1960). In Italian.

Statistical results are given for active plages observed in K-light throughout 1959. Tabulated data on daily frequency and projected areas, together with monthly, bi-annual, and annual means of these two criteria are included. Histograms are reproduced to show the distribution of plages in N and S solar hemispheres. D.R.Barber

2617 THE OBSERVATION OF A SOLAR EVENT IN WHITE LIGHT FROM RESOLUTE, N.W.T.,ON AUGUST 30, 1957. L.R.McNarry.
J. Roy. Astron. Soc. Canada, Vol. 54, No. 6, 273-4 (Dec., 1960).

Whilst operating an auroral radar on 48 Mc/s in North-West Territory, Canada, a solar noise storm was recorded between 2320 hr and 0100 hr U.T. on Aug. 30, 1957. During the progress of this storm a bright flare was seen on the solar disk at 2330 hr U.T. with the aid of a dark (welding) glass filter and 6× binoculars. The flare was adjacent to a large sunspot group (McMath plage region 4124), its intensity (in white light) being much greater than that of the surrounding photosphere. The feature was readily discernible for at least 20 min. D.R.Barber

2618 CORONAL OBSERVATIONS ON THE DAY OF THE SOLAR ECLIPSE OF 1959 OCTOBER 2. R.Müller.
Observatory (GB), Vol. 79, 211-12 (Dec., 1959).

Observed values of the intensities of the coronal emission at 5303 and 6374 A are tabulated for E. and W. solar limbs; a diagram is reproduced to show the profiles of the monochromatic corona and limb prominences on both sides of the solar equator. D.R.Barber

2619 THE INFLUENCE OF THE CHROMOSPHERE ON SOLAR LIMB DARKENING. B.E.J.Pagel.
Astrophys. J. (USA), Vol. 132, No. 3, 790-800 (Nov., 1960).

Source-function distributions compatible with observations of darkening at the extreme solar limb are found by means of an analytical expansion. It is shown that continuous emission from the chromosphere makes a significant contribution to the intensity for $\mu \leq 0.2$. When this effect is allowed for, the observations imply the presence of a temperature minimum between 3900° and 4700° in the photosphere in the region $0.01 < \tau_0 < 0.04$.

2620 SOME OBSERVATIONS OF THE Hα LINE AT THE SOLAR LIMB. S.V.M.Clube.
Observatory (GB), Vol. 79, 214-16 (Dec., 1959).

The line was observed on the disk, and in the chromosphere, with the Oxford 19.8 m solar telescope and diffraction grating at a dispersion of 0.7 A/mm in the first order, under conditions of excellent "seeing". Hα profiles out to ±3 A were obtained from a calibrated spectrum of fine quality, photographed on Sept. 24, 1958, for the region between 11' of arc inside the solar limb and 7' beyond the limb at 0.5" intervals. The profiles were corrected for spectrograph and microphotometer slit patterns, and also for the effects of atmospheric scintillation. The observed profile was found to have two components, one in absorption and the other in emission, the former being very deep and of width ~ 2 A, and absent in the chromosphere. A diagrammatic representation of the corrected emission and absorption profiles is reproduced. D.R.Barber

OPTICAL OBSERVATIONS OF SOLAR DISTURBANCES CAUSING TYPE II RADIO BURSTS. See Abstr. 2655

2621 AREA–INTENSITY INTEGRATOR FOR SOLAR FLARES. W.A.Feibelman.
Astrophys. J. (USA), Vol. 133, No. 1, 269-73 (Jan., 1961).

A new tool for solar research is described. The laboratory model simulates conditions of the sun as observed with a spectrohelioscope or Lyot-type filter, with which the instrument is to be used. The product of the area times the intensity of flares is measured electronically without the need for photography, resulting in a more precise measure of flare activity than is now used.

2622 A STATISTICAL STUDY OF THE DIMENSIONS OF BRIGHT FLARES IN HYDROGEN-LIGHT OBSERVED AT ARCETRI, CAPRI SVEZIA, HAWAII, MACMATH, MITAKA, AND U.S. NAVAL OBSERVATORY. M.C.Ballario.
Mem. Soc. Astron. Ital., Vol. 31, No. 2-3, 329-59 (1960). In Italian.

Results from 6 solar observatories, yielding a statistical relationship between projected flare area, A_p, and heliocentric angle, Θ, are examined and discussed. Data from 2500 flares is divided among ten groups covering the range $\Theta = 0°$ to 90° in 10° steps. It is shown that the equation, $A_C = A_p \sec \Theta$, where A_C is the area corrected for projection angle, is valid only within the angular limits $\Theta = 0°$-50°. Above 50°, computed values of A_C appear too large: thus it is necessary to apply a correction smaller than sec Θ such that $A_0/A_{90} \cong 5$. On using the appropriate corrections for the two ranges, $\Theta = 0°$ to 49°, and $\Theta = 50°$ to 90°, the mean values of to be independent of the heliocentric angle, Θ. D.R.Barber

2623 THE ROTATIONAL VELOCITY OF POLAR PROMINENCES. A.Bruzek.
Z. Astrophys. (Germany), Vol. 51, No. 2, 75-8 (1961). In German.

Using observational data based on records obtained at the Anacapri Observatory of the Fraunhofer Institute in 1956-9, average values of the sidereal rotation angle are computed for solar prominence features in the solar latitude range, from 45° to 80°, using two different methods. Over this range the weighted mean value of the daily angular rotation Θ is given by the relation

$$\Theta = 13°.36 - 0°.065(\phi - 45°),$$

where ϕ is the heliocentric latitude. D.R.Barber

2624 MASS DENSITY NEAR THE SUN.
Nature (GB), Vol. 188, 111-12 (Oct. 8, 1960).

Report on the studies by Hill, Bulletin of the Astronomical Institutes of the Netherlands, Vol. 15, p. 1, and Oort, ibid., p. 45 1960) . A statistical analysis of the velocity distribution of K-stars (from proper-motion data) is used to obtain the magnitude of the gravitational attraction of the Galaxy (perpendicular to its plane) in the near vicinity of the sun. From this result, the total density of matter in the galactic plane close to the sun is computed, and found to be 9.2×10^{-24} g cm^{-3}, or 0.13 $M_\odot$/cubic parsec, a value somewhat larger than that previously found by Oort (1932), although in good agreement with a re-determination by the same investigator. D.R.Barber

2625 PHYSICAL ATMOSPHERIC PARAMETERS FOR LATE-TYPE STARS. M.S.Vardya.
Astrophys. J. (USA), Vol. 133, No. 1, 107-29 (Jan., 1961).

For a gas mixture, the relation between total gas pressure, partial pressure of atomic hydrogen, mean molecular weight, and several other auxiliary quantities has been determined as a function of electron pressure and $\theta = 5040/T$, for three hydrogen-to-helium abundance ratios. The effect of molecular hydrogen has been incorporated.

2626 ON STELLAR MODELS WITH DOUBLE ENERGY-SOURCES. M.Nishida.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 896-902 (May, 1960).

To investigate the characteristics of stellar models having double energy-sources, three sample models ($M = 1.2\ M_\odot$) were constructed using the newest rate of the CN-cycle, and consisting of the following regions: (1) hydrogen-rich envelope, (2) radiative helium region and (3) convective helium core. A model for which the mass fraction of the helium regions is 0.6 shifts towards the left of the RR Lyrae gap in the HR-diagram from the red giant region, in which the corresponding model of Hoyle and Schwarzschild lies. This result shows that the properties of such models are very sensitive to the rates of both the hydrogen- and helium-burning.

2627 ON THE LOCATION OF BETA CEPHEI STARS IN THE THEORETICAL HERTZSPRUNG-RUSSELL DIAGRAM. D.C.Schmalberger.
Astrophys. J. (USA), Vol. 132, No. 3, 591-3 (Nov., 1960).

Fifteen β Cephei stars, an observational zero-age main sequence, and evolutionary tracks for some massive stars are plotted in the same theoretical H-R diagram. Several conclusions are inferred from the position of the variables in the diagram.

2628 MODELS OF MASSIVE PURE HYDROGEN STARS. D.Ezer.
Astrophys. J. (USA), Vol. 133, No. 1, 159-65 (Jan., 1961).

If our galaxy was initially composed of pure hydrogen, then the first stages of element formation would take place in massive stars condensing from such a medium. "Main-sequence" models have been constructed for pure hydrogen stars ranging in mass from 1 to 2000 $M_\odot$. It was found that there is a remarkably high average density in such models and that convection takes place in their cores. However, most of the models are purely formal ones, since appreciable helium formation takes place before such stars have fully contracted toward the main sequence. In stars of mass greater than about $26_\odot$ sufficient C^{12} will form from this initial helium to alter the main-sequence structure through energy generation by the carbon cycle.

2629 MODEL FOR A HELIUM STAR OF 1 SOLAR MASS. J.B.Oke.
Astrophys. J. (USA), Vol. 133, No. 1, 166-9 (Jan., 1961).

A model for a homogeneous star of 1 solar mass and chemical composition given by $X = 0.000$, $Y = 0.999$, and $Z = 0.001$ has been constructed. The convective core extends to $r/R = 0.23$; the energy generation from the triple-alpha reaction is confined to the core. The opacity assumed in the model differs significantly from electron scattering in the outer parts of the star and is in good agreement with that computed from opacity tables. The luminosity, radius, effective temperature, and absolute bolometric magnitude are given in equation form.

2630 A PRELIMINARY ANALYSIS OF THE EFFECTIVENESS OF SECOND HELIUM IONIZATION IN INDUCING CEPHEID INSTABILITY IN STARS. J.P.Cox.
Astrophys. J. (USA), Vol. 132, No. 3, 594-626 (Nov., 1960).

A program of numerical calculations, was made with an IBM 704 computer to test the suggestion [Zhevakin (1953, 1954); Cox and Whitney (1958); Cox (1959)] that second helium ionization, occurring at a critical depth in a stellar envelope, is the ultimate source of cepheid instability. Simplified, purely radiative envelope models were adopted for stars of prescribed mass, luminosity, radius, and chemical composition, and the negative dissipation in the envelopes was computed numerically as a function of these parameters. The Woltjer theory in the first approximation was used to obtain the non-adiabatic flux and temperature variations, from which the negative dissipation in the envelopes could be computed. Second helium ionization was explicitly included in the calculations, but first helium ionization and hydrogen ionization were omitted. A strong destabilizing influence, resulting from second helium ionization, was revealed in the envelope models for population I cepheids, assuming reasonable helium abundances. The magnitude of the negative dissipation in the envelopes was comparable to the estimated positive dissipation in the interiors, for reasonable radii. For log L (solar units) = 3.13 and B (helium/hydrogen ratio, by numbers) = 0.15, maximum instability for the entire star was attained for a radius about 1.6 times larger than the empirical value. For these same values of log L and B and for radii near the observed values, the amplitude of the surface flux variations was about 0^m7 or 0^m8 and the phase lag (relative to minimum radius) was about 40° or 50°. It may be inferred that first helium and hydrogen ionizations are not primary causative agents in producing pulsational instability, at least for the kinds of envelopes considered here. These ionizations, however, had they been included in the calculations, would have increased the magnitude of the pulsational instability (through indirect effects) and would have brought the surface flux variations into closer agreement with observation than the present calculations show. Results for population II cepheids were inconclusive because the low surface gravities of these stars invalidated some of the approximations that were used.

2631 ON THE SHAPE OF MAGNETIC STARS. D.G.Wentzel.
Astrophys. J. (USA), Vol. 133, No. 1, 170-83 (Jan., 1961).

The integration of the simplest of the equations governing a compressible hydromagnetic equilibrium (Woltjer 1960) with a density distribution similar to that of actual stars results in a magnetic field whose strength is roughly proportional to the density throughout most of the star. Hence there may exist strong central magnetic fields whose only observable effect is a distortion of the star as a whole. Surfaces of constant density in distorted magnetic stars are expected to be spheroidal. A variational calculation results in a simple formula for the eccentricity of the spheroids, provided that it is small. On the basis of particular models for the density, it is concluded that the distortions are significant if the magnetic energy is 6% or more of the gravitational potential energy. For the models considered, the spheroids are found to be prolate.

2632 THE CONVECTIVE INSTABILITY OF A RADIATING FLUID LAYER. E.A.Spiegel.
Astrophys. J. (USA), Vol. 132, No. 3, 716-28 (Nov., 1960).

The thermal stability of a grey, radiation fluid layer with an adverse temperature gradient is studied. It is assumed that the vertical dimension of the layer is much less than the scale height of density or pressure. By essentially dimensional reasoning it is shown that convection can occur when a non-dimensional parameter, analogous to the Rayleigh number, exceeds a certain critical value. The formal study begins from the same equations as the classical study of Rayleigh, with the addition of a radiative term to the heat equation. It is shown that if the difference between the temperature gradient and the adiabatic gradient is constant, overstability cannot occur. An equation of marginal stability is then derived. By means of a variational principle, critical values of the non-dimensional stability parameter and of the scale of the most unstable disturbance are computed for the case of rigid bounding surfaces. The critical value for instability is given as a function of the optical thickness of the layer. Finally, the convective stability of the atmosphere of a B0 star is discussed in terms of these results.

2633 ON THE SPECTRUM OF TURBULENT CONVECTION. P.Ledoux, M.Schwarzschild and E.A.Spiegel.
Astrophys. J. (USA), Vol. 133, No. 1, 184-97 (Jan., 1961).

A procedure is described by which, under certain assumptions, the turbulence spectrum can be derived for the motions in a convectively unstable layer. The energy input from the buoyancy forces is assessed in this procedure by deriving the growth rates of the laminar modes obtained from the relevant linearized equations. On the other hand, the exchange of energy between modes is assumed to follow Heisenberg's elementary theory of turbulence. The procedure is carried through for an exceptionally simple case for which a closed solution was found for the spectrum. The results, though not strictly applicable, are applied to the convection in the solar photosphere for purposes of orientation.

2634 ON INHOMOGENEOUS STELLAR ATMOSPHERES. I.W.Busbridge.
Astrophys. J. (USA), Vol. 133, No. 1, 198-209 (Jan., 1961).

The paper discusses the problem of a plane-parallel stellar

atmosphere in which there is isotropic scattering at any given optical depth but in which the albedo for single scattering varies with the optical depth. The general solution for the emergent intensity, when the upper and lower surfaces of the atmosphere are subject to known incident radiation, is shown to depend on the solutions of two independent problems: that in which the atmosphere has a fixed lower surface, free from incident radiation, and a variable upper surface, on which radiation is incident at a fixed angle with the normal, and that in which the roles of the lower and upper surfaces are interchanged. The paper discusses and relates the work of Sobolev (Abstr. 1646 of 1958) and Ueno (Abstr. 2719 of 1961).

2635 CLASSICAL FORMULA FOR COLOUR TEMPERATURE. G.Romano.
Mem. Soc. Astron. Ital., Vol. 31, No. 2-3, 369-70 (1960). In Italian.

The expression $T = 7200/(0.64 + I)$ for the colour temperature (T) of a star in terms of its colour index (I) can be derived from the Wien expression connecting spectral intensities at two effective wavelengths, 0.425 and 0.529 mμ, taking the colour index and the colour temperature of the sun as 0.57 and 6000°K respectively.
J.W.T.Walsh

2636 NEUTRINO EMISSION FROM BLACK-BODY RADIATION AT HIGH STELLAR TEMPERATURES. H.-Y.Chiu and P.Morrison.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 573-5 (Dec. 5, 1960).

Attention is drawn to the importance of the neutrino emission processes (1) $e^- + e^+ \rightarrow \nu + \bar{\nu}$, (2a) $\gamma + \gamma \rightarrow \nu + \bar{\nu}$ and (2b) $\gamma + \gamma \rightarrow \gamma + \nu + \bar{\nu}$ at temperatures of the order of 10^9 °K. Calculations are made of the rate of energy loss by neutrino emission for process (1), and estimates are made for (2b). It is suggested that energy loss by neutrino flux through a star would make gravitational contraction possible, approximately under conditions of thermal equilibrium, until the onset of a supernova explosion. The first indication of such an explosion would be a high neutrino flux from the stellar surface. This flux might be detectable, and make possible the prediction of supernova outbursts.
R.A.Newing

2637 GEOMETRIC BROADENING OF STELLAR SPECTRAL LINES. Su-Shu Huang.
Astrophys. J. (USA), Vol. 133, No. 1, 130-8 (Jan., 1961).

A general formula for deriving the broadening function as a result of the difference in line-of-sight motion of absorbing or emitting medium at different parts of a stellar disk is derived by use of the "isoradial velocity-curves". This formula is applied to the study of differential rotation of a single, as well as an eclipsed, star.

SHOCK-WAVE PROPAGATION IN INHOMOGENEOUS GASES. APPLICATION TO THE THEORY OF NOVA EXPLOSIONS.
See Abstr. 2780

2638 NUCLEOSYNTHESIS IN SUPERNOVAE. F.Hoyle and W.A.Fowler.
Astrophys. J. (USA), Vol. 132, No. 3, 565-90 (Nov., 1960).

The role of Type I and Type II supernovae in nucleosynthesis is treated in some detail. It is concluded that e-process formation of the iron-group elements takes place in Type II supernovae, while r-process formation of the neutron-rich isotopes of the heavy elements takes place in Type I supernovae. The explosion of Type II supernovae is shown to follow implosion of the non-degenerate core material. The explosion of Type I supernovae results from the ignition of degenerate nuclear fuel in stellar material.

2639 WAVE LENGTHS OF FORBIDDEN NEBULAR LINES. II. I.S.Bowen.
Astrophys. J. (USA), Vol. 132, No. 1, 1-17 (July, 1960)

For previous work, see ibid., Vol. 121, No. 2, 300-5 (March, 1955). The observations of forbidden-line wavelengths in nebulae are extended further into the ultraviolet with a new quartz camera at the coudé spectrograph of the Mt.Wilson 100 in. telescope. The present status of the determination of the wavelengths of the forbidden lines from both astronomical observations and laboratory analyses is reviewed. Tables list the best current value of the wavelength and data on probable accuracy and intensity for the forbidden lines of ions in the first three rows of the periodic table.

2640 PHOTOMETRY AND RADIOMETRY OF GASEOUS NEBULAE. D.E.Osterbrock and R.E.Stockhausen.
Astrophys. J. (USA), Vol. 133, No. 1, 2-10 (Jan., 1961).

Photoelectric observations of the diffuse nebula NGC 281 in the light of the emission lines Hβ and [O III] N1 are reported. The observations were made by comparing this nebula with small planetary nebulae with known fluxes. A measurement of the radio-frequency continuum flux from the nebula at a wavelength of 22 cm is also reported; this measurement was made by comparison with the radio source Cas A. The Hβ and radio-frequency fluxes, when interpreted in terms of the theory of thermal radiation, are discrepant, but the discepancy is only slightly larger than the probable errors involved and can be made to vanish by relatively minor changes in the assumptions. Measurements of the fluxes in the Hβ and [O III] N1 lines from three planetary nebulae with large angular diameters are reported, and it is shown that NGC 6853 is the brightest known planetary in Hβ, and therefore a likely object to be observed as a radio source.

2641 ON GAS EXPANSION IN THE CENTRAL PARTS OF THE GALAXY. S.Grzędzielski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 10, 627-32 (1959).

A simple aerodynamic interaction between neutral hydrogen and H II regions submerged in an axially symmetric magnetic field is invoked as a braking mechanism to explain the sudden velocity decrease of the expanding gas in the region of about 3-4 kiloparsecs from the galactic centre. A transverse field of the order of 10^{-5} gauss is sufficient to stop the expanding gas and to produce the observed H I density increase.
G.A.Chisnall

2642 SPECTRA AND OTHER CHARACTERISTICS OF INTERCONNECTED GALAXIES AND OF GALAXIES IN GROUPS AND IN CLUSTERS. I. F.Zwicky and M.L.Humason.
Astrophys. J. (USA), Vol. 132, No. 3, 627-39 (Nov., 1960).

Some of the pertinent characteristics of four double galaxies have been investigated. The two component galaxies in each of these systems are separated by two to five times their diameters, and they are interconnected and surrounded by intergalactic luminous formations. The symbolic velocities of recession and the apparent dimensions and luminosities of the various parts of these systems were determined, and, from them, indicative absolute dimensions, luminosities, and masses were derived. These lie within rather narrow limits. This result may be interpreted as meaning that only galaxies of a certain size and mass can, on collision or otherwise, give rise to extended luminous intergalactic formations. Further data on similar systems and on larger groups of galaxies will be presented shortly. With data of this kind it appears possible to establish a relative extragalactic distance scale. Furthermore, information on the important problem will be obtained relating to the ratio of the total luminous to the total dark mass in associations of increasing size.

Radioastronomy

2643 A NEW RADIO TELESCOPE OF HIGH RESOLVING POWER. S.E.Khaikin and N.L.Kaidanovkii.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 166-70.

The radio telescope at Pulkovo Observatory consists of 90 reflecting elements each 1.5 m × 3.0 m arranged in a horizontal arc. These focus the incoming radiowaves on to a receiving horn. Such an arrangement has the mechanical stability to give the high azimuth resolution of 1 min of arc at 3.2 cm wavelength. The zenithal resolution ranges between 10 and 60 min of arc depending upon the elevation of the incoming signal.
R.D.Davies

2644 SOLAR RADIO BRIGHT SPOTS AT 88 cm WAVELENGTH. J.Firor.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 136-9.

The bright spots observed appear to be the longwave counterpart of the slowly varying component seen at decimetre wavelengths. The apparent temperature is in the range 10^6-10^7 °K. Some bright spots give rise to numerous bursts and seem to correspond to the noise storms familiar at metre wavelengths.
R.D.Davies

2645 THE SLOWLY VARYING COMPONENT OF SOLAR EMISSION AT 169 Mc/s. A.Boischot and P.Simon.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 140-2. In French.

Daily observations were made with a 32-element interferometer from June 1956. The bright centres have dimensions of 10 minutes of arc and are found within 1.3 solar radii of the central meridian. Their positions do not agree closely with those of the slowly varying component at 3 cm. The quiet sun has a diameter of 54 ± 2 minutes of arc between points of 10 percent of the peak intensity.

R.D.Davies

2646 A STATISTICAL STUDY OF THE SLOWLY VARYING COMPONENT BASED ON OBSERVATIONS BETWEEN 10 000 AND 600 Mc/s. B.Vauquois.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 143-8. In French.

An attempt is made to obtain a representation of an average centre of radio emission in terms of its variation with time and frequency and its relation to sunspot areas and plage intensities. A model of a radio centre is presented. R.D.Davies

2647 A MODEL OF ELECTRON CORONA WITH REFERENCE TO RADIO OBSERVATIONS. G.Newkirk, Jr.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 149-58.

Observations with a K-coronameter were made out to one solar radius above the limb. A measure of the electron density in the quiet corona, polar regions and active regions is obtained. The measured densities in the active regions can be used with a suitable choice of electron temperature to account adequately for the slowly varying component observed at decimetre wavelengths.

R.D.Davies

2648 SOLAR EMISSION AT 10 cm WAVELENGTH. A.E.Covington.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 159-65.

Relative measurements of the mean monthly flux of 10 cm radio-emission from the sun have been continued since 1947, thus covering two sunspot maxima. Bursts appear to fall into two classes, one being a class of short-lived intense bursts and the others being long-enduring and some ten times weaker. Drift curves with an interferometer having a resolution of 1 min of arc in the E-W direction have resolved the active areas on the sun at 10 cm wavelength. R.D.Davies

2649 SOLAR OBSERVATIONS WITH THE LARGE PULKOVO RADIO TELESCOPE AT 3.2 cm WAVELENGTH. V.Ikhsanova.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 171-3.

One-dimensional scans of the sun showed that the active regions associated with sunspots are about 1 min of arc in diameter. The corresponding brightness temperatures lie in the range $(0.3 - 1.0) \times 10^6$ °K. The height of the region was found to be 1.07 solar radii from the centre of the sun. The telescope is described in Abstr. 2643. R.D Davies

2650 PRELIMINARY RESULTS OF RADIO-ASTRONOMICAL OBSERVATIONS OF ANNULAR SOLAR ECLIPSE, APRIL 19, 1958.
A.P.Molchanov, Chen Fan-Yun, Wang Shou-Kuang, E.G.Merzabekian and A.E.Salomonovich.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 174-5.

Observations were made at seven frequencies in the range 0.8 to 50 cm. The sizes of active regions on the sun were found to be close to those of the associated sunspots. Polarization was not detected at the shorter wavelengths. The observed distribution was limb-brightened at about 5 cm wavelength. R.D.Davies

2651 THE TRANSVERSE MOTIONS OF THE SOURCES OF SOLAR RADIO BURSTS.
J.P.Wild, K.V.Sheridan and G.H.Trent.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960). p. 176-85.

A swept-frequency interferometer was used to measure east–west movements of solar bursts at frequencies in the range 40 to 70 Mc/s. Type III bursts showed disturbances moving outwards at velocities about 0.3 of the velocity of light; the emission at a given frequency is stationary in height. Type II bursts have similar positional features although the outward velocity is only about 500 km/sec. Type IV bursts show a disturbance moving outwards at all frequencies at a velocity of about 5000 km/sec. Type V is suggested as a new class of burst with similar positional characterestics to type IV but having a greater bandwidth and intensity but a smaller duration. R.D.Davies

2652 TYPE IV [SOLAR] EMISSIONS. A.Boischot.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960 p. 186-7.

Measurements with a 32-element interferometer at 169 Mc/s showed that the enduring type IV radiation observed after a type II burst comes from an extended region some 10 min of arc in diameter. It moves in the solar corona and may be found at heights of 0.3 to 5.0 solar radii above the photosphere. Since the apparent temperatures may be as large as 10^{12} °K it is suggested that type IV radiation is synchrotron radiation. R.D.Davies

2653 SOME CHARACTERISTICS OF DYNAMIC SPECTRA OF SOLAR BURSTS. F.T.Haddock.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 188-93.

Sweep-frequency receivers were used which covered the band 100 to 580 Mc/s. Fine structure was observed within type II bursts. A type IV event was observed only at frequencies above 360 Mc/s. Simultaneous V bursts were harmonically related and they all have similar durations. R.D.Davies

2654 SOME ASPECTS OF TYPE II BURSTS. J.A.Roberts.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960 p. 194-200.

An analysis is made of the dynamic spectra of 65 Type II bursts. Some 20 per cent showed a "herringbone" pattern which suggests Type III bursts are stimulated by the outward passage of the Type II disturbance. Harmonic structure is also a common feature. The emission band is split in frequency; this is attributed to Zeeman splitting. Also a close statistical correlation is found between Type II bursts and the occurrence of magnetic storms 2-5 days later.

R.D.Davies

2655 OPTICAL OBSERVATIONS OF SOLAR DISTURBANCES CAUSING TYPE II RADIO BURSTS.
R.G.Giovanelli and J.A.Roberts.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960 p. 201-2.

Flares, ejected prominences, disappearing filaments and surges appeared to have caused 13 of the 15 type II bursts observed during times of observation with the Sydney H α flare patrol camera. Only supersonic limb ejections were associated with type II bursts.

R.D.Davies

2656 A PRELIMINARY STUDY OF THE DYNAMIC SPECTRA OF SOLAR RADIO BURSTS IN THE FREQUENCY RANGE 500-950 Mc/s.
C.W.Young, C.L.Spencer, G.E.Moreton and J.A.Roberts.
Astrophys. J. (USA), Vol. 133, No. 1, 243-54 (Jan., 1961).

Three new features: (1) The broad-band continuum radiation, which is the chief feature of the major outbursts of activity, is often resolved into a succession of bursts of very short duration (< 0.3 sec); (2) intermediate-drift bursts of short duration (<1 sec one frequency) and drifting from high to low frequencies at rates ~ 30 Mc/s per sec commonly occur as components of the major out bursts; (3) fast-drift bursts are observed having both senses of frequency drift.

2657 A COMPARISON OF THE DYNAMIC SPECTRA OF SOLAR RADIO BURSTS IN THE DECIMETER- AND METER-WAVELENGTH RANGES.
M.R.Kundu, J.A.Roberts, C.L.Spencer and J.W.Kuiper.
Astrophys. J. (USA), Vol. 133, No. 1, 255-7 (Jan., 1961).

The existence of two classes of fast-drift (Type III) bursts is recognized from a comparison of the dynamic spectra of solar radio bursts observed at the University of Michigan in the 100-580 Mc/s range and, in some cases, in the 2000-4000 Mc/s range and at

Convair-Caltech in the 500-950 Mc/s range. One class corresponds to the metre-wavelength bursts and predominantly extend to the low-frequency edge of records at 100 Mc/s and the other to the decimetre-type bursts which are observed to terminate mainly above 400 Mc/s and typically between 400 and 550 Mc/s. An example is given of an event in which the 500-950 Mc/s range shows a short continuum increase in time coincidence with a group of metre-wavelength Type III bursts preceding a Type II burst. Another example of a similar event shows that the continuum increase exists at higher frequencies (< 2000 to > 4000 Mc/s).

2658 POLARIZATION MEASUREMENTS OF TYPE III BURSTS AND FARADAY ROTATION IN THE CORONA. K.Akabane and M.H.Cohen.
Astrophys. J. (USA), Vol. 133, No. 1, 258-68 (Jan., 1961).

A theory of depolarization by Faraday dispersion of position angles is presented. There is a Fourier transform relation between the receiver band shape and $\mu r1$, the complex correlation factor between the two circularly polarized components. A series of observations shows that (a) many of the large Type III bursts are weakly elliptically and linearly polarized in a 10 kc/s band at 200 Mc/s, and (b) $|\mu r1|$ decreases with increasing receiver band width. These results are interpreted in terms of Faraday rotation in the corona. Many bursts have rotations on the order of 10^4 radians.

2659 MICROWAVE ABSORPTION AND EMISSION IN THE ATMOSPHERE OF VENUS. A.H.Barrett.
Astrophys. J. (USA), Vol. 133, No. 1, 281-93 (Jan., 1961).

The radio-astronomical observations of Venus are analysed in terms of a model atmosphere and the known microwave absorbing properties of CO_2 and H_2O. The model atmosphere is taken to consist of an adiabatic region with a temperature gradient of 9.0°K/km and an isothermal region with a scale height of 6.86 km and a temperature of 285°K. The surface temperature is assumed to be 580°K. The centimetre and millimetre radio data require surface pressures between 10 and 30 terrestrial atmospheres on the basis of the assumed model and atmospheric compositions of 75 per cent CO_2, 22-25 per cent N_2, and 0-3 per cent H_2O.

2660 MAGNETIC FIELD OF JUPITER. C.H.Barrow.
Nature (GB), Vol. 188, 924-5 (Dec. 10, 1960).

A discussion of observations of decametre radiation from Jupiter, in terms of radio propagation theory, leads to the conclusion that the electronic gyrofrequency in the planet's ionosphere lies between 13 Mc/s and 22 Mc/s. If the magnetic field is due to a dipole whose axis is the rotational axis of the planet, the polar intensity would be about 7 gauss. Hypotheses of the origin of the radio emission are briefly discussed. It is suggested that a mechanism involving plasma oscillations in the Jovian ionosphere is not inconsistent with available data. H.Rishbeth

2661 RADIO ECHO OBSERVATIONS OF METEOR ACTIVITY BETWEEN 1954 DECEMBER AND 1958 DECEMBER. G.C.Evans.
Jodrell Bank Ann. (GB), Vol. 1, No. 6, 280-337 (Nov., 1960).

Results of the continuous meteor surveys are presented. Observations were made with the fixed aerial radiant survey apparatus and the rotating aerial equipment. A new shower in Bodtes has been detected by both equipments.

2662 ON A FEATURE OF THE GALACTIC RADIO EMISSION. H.M.Johnston.
Phil. Mag. (GB), (Eighth Ser.), Vol. 4, 877 (July, 1959).

A criticism of the theory of Tunmer (Abstr. 2738 of 1958) which seeks to explain the well-known "spur" of radiation projecting from the galactic plane near $l^{II} = 30°$ as due to directional emission from relativistic electrons spiralling about a magnetic field aligned along the local arm. There is an unacceptable discrepancy of 58° between the observed direction of the field near the sun and the direction required of it by Tunmer. C.Hazard

2663 A SHELL SOURCE OF RADIO EMISSION. P.R.R.Leslie.
Observatory (GB), Vol. 80, 23-6 (Feb., 1960).

A comparison of total power and interferometer observations of the intense extended source 3C 392, suggests that the emission occurs within a thin spherical shell about 22.5 min of arc in diameter, the shell thickness being less than 2.5 min of arc. The spectrum is similar to that of supernovae remnants, such as the Cygnus Loop, and this together with the shell structure suggests that it is also a supernova remnant. C.Hazard

2664 A RADIOMETER FOR HYDROGEN-LINE EXTRA-GALACTIC STUDIES AND FOR CONTINUUM OBSERVATIONS. R.D.Davies and R.C.Jennison.
Jodrell Bank Ann. (GB), Vol. 1, No. 6, 351-62 (Nov., 1960).

A hydrogen line spectrometer used on the Jodrell Bank 250 ft radio telescope for the investigation of the extragalactic and intergalactic absorption spectra of Cygnus-A is described. This spectrometer was designed to scan a wide range of frequencies and used a switched reference channel spaced 6 Mc/s from the signal channel. The instrument was also used as a narrow-band spectrometer for galactic absorption measurements and as a straight radiometer for total power investigations of selected objects. The aerial beam pattern is analysed to provide estimates of the brightness temperature and the flux density of continuum sources.

2665 HIGH RESOLUTION STUDIES WITH THE 250 FT RADIO TELESCOPE AT JODRELL BANK. R.D.Davies and R.C.Jennison.
Observatory (GB), Vol. 80, 74-7 (April, 1960).

An account of a 22 cm wavelength survey of the continuum radiation from Sagittarius-A, Cygnus-X and the moon. The beam-width was 15 min of arc in both the E and H-planes. Sagittarius-A appears to consist of a broad source aligned in the plane of the Galaxy with a narrow source situated near its centre. C.Hazard

2666 OBSERVATIONS OF RADIO SOURCES AT FOUR FREQUENCIES. D.S.Heeschen.
Astrophys. J. (USA), Vol. 133, No. 1, 322-34 (Jan., 1961).

Observations of radio sources at four frequencies in the range 440-8000 Mc/s are described. To achieve as high internal consistency as possible in the data, the observations were made in the form of ratios to a standard source. Some characteristics of the source spectra derived from the observations are briefly discussed.

2667 A SURVEY OF THE LOCALISED RADIO SOURCES AT A FREQUENCY OF 92 Mc/s. C.Hazard and D.Walsh.
Jodrell Bank Ann. (GB), Vol. 1, No. 6, 338-50 (Nov., 1960).

The results of a total power survey made using the fixed 218 ft paraboloid at Jodrell Bank are given. The results of an interferometer survey are also given, the 218 ft paraboloid being used as one element of the interferometer, the other element consisting of a fixed array of dipoles. The two lists of sources are compared and it is shown that agreement between the lists is poor. It is suggested that the majority of the disrepancies are the result of confusion.

PHOTOMETRY AND RADIOMETRY OF GASEOUS NEBULAE.
See Abstr. 2640

Space Research

2668 ON SIMULATION STUDIES OF MOTION OF BODIES IN IONIZED ATMOSPHERE. K.P.Chopra.
Z. Phys. (Germany), Vol. 161, No. 4, 445-53 (1961).

The principle of dimensional similitude is applied to the laboratory model studies of the motion of bodies in an ionized atmosphere pervaded by a magnetic field. The correspondence relationships of various characteristic parameters in the actual and laboratory model scale cases are obtained. It is shown that the scaling relationships satisfy the conditions for aerodynamic, magnetohydrodynamic and electrodynamic similitude. These relationships indicate that it is not necessary to obtain actual atmospheric densities in the laboratory to perform such studies. By adopting a suitable scaling factor for the linear dimension of the body, it should be possible to simulate flight conditions corresponding to the upper atmosphere of the earth. Outline details of a suitable experiment in a hypersonic wind tunnel are described.

2669 A NOTE ON THE POSSIBILITY OF PHOTOGRAPHING A SATELLITE NEAR THE MOON. J.S.Courtney-Pratt.
J. photogr. Sci. (GB), Vol. 9, No. 1, 36-55 (Jan.-Feb., 1961).

It would be desirable when a missile is sent to the moon to be able to determine the point of impact. Optical methods are possible. The light levels are considered with regard to the photo-

graphic requirements. Calculations are presented of the light reflected by a matt white spherical satellite near the moon. The brightness of the image of the satellite in a photographic telescope is compared with the brightness of the image of the moon. Quantum considerations would in any case set a lower limit to the size of the satellite that could just be detected. Recent work on the granularity of photographic emulsions and on probability criteria for detection of a signal in the presence of noise, shows that a photographic emulsion falls far short of an ideal detector. Nevertheless, it would certainly be possible with any of a number of existing telescopes to detect small satellites with a high degree of certainty. The minimum satellite radii for a number of particular cases for photographic detection against the sunlit side of the disk of the moon are given, together with the more interesting results of minimum satellite radii for detection against, as background, the dark, or earthlit, side of the moon. It is shown that with any of a number of existing telescopes, by proper choice of emulsion and exposure conditions, it would be possible to record and detect satellites with radii less than one metre. However, half of this figure would be about the extreme limit.

PHOTOGRAPHING A SATELLITE NEAR THE MOON.
See Abstr. 2669

2670 ON THE MAGNETIC DAMPING OF ROTATION OF ARTIFICIAL SATELLITES OF THE EARTH. L.LaPaz.
J. geophys. Res. (USA), Vol. 65, No. 7, 2201-2 (July, 1960).

This note criticizes an earlier treatment (Abstr. 4910 of 1960) on the theoretical evaluation of the magnitude of eddy current damping of the spinning motion of an earth satellite. It is shown that the basic integral

$$1(e,\rho) = \int_0^{\pi} \frac{dM}{[r(M)/a]^{\rho}}$$

can be solved, and the following value is quoted:
$1(0.19, 3) = 1.056\,700\,783\,9\pi$. H.J.A.Chivers

2671 OPTICAL OBSERVATIONS OF THE SECOND RUSSIAN EARTH SATELLITE. A.Hattori and B.Yada.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 107-39 (Sept., 1959).

Observations of 1957β were carried out at Kwasan Observatory, Kyoto University, in cooperation with the Western Japanese Moon Watch Stations. The instruments used are described and the orbital elements are determined. On March 20.000 (J.S.T.), 1958, the period T was $94.^m477 \pm 0.^m003$, the eccentricity 0.0434 ± 0.0020, and perigee and apogee heights were 195 km ± 14 km and 791 km ± 14 km respectively. The inclination of orbit to the equatorial plane, i, is estimated as $65.^\circ5 \pm 0.^\circ2$. The period shows erratic variations. $\Delta\Omega$, the retrograde rate of orbit per day, may be connected with the period by an empirical formula:

$$\Delta\Omega = (1.08 \pm 0.01) \times 10^5 \cos i \times T^{-2.1 \pm 0.1}.$$

Finally, the air density at about 195 km altitudes above the equatorial regions is estimated as 6 to 10×10^{-10} kg m^{-3}.

2672 SPIN RATE OF THE SATELLITE ECHO I AS DETERMINED BY A TRACKING RADAR. G.E.K.Lockwood.
Canad. J. Phys., Vol. 38, No. 12, 1713 (Dec., 1960).

Observations of the scintillation rate of a received signal reflected from Echo I, using polarized aerials, show that an increased rate occurred between revolutions number 131 and 217, interpreted as an increase in the spin rate of the satellite from 1.63 to 1.88 rev/min. This is probably due to a shrinkage of the balloon associated with the satellite's excursions into the earth's shadow, which first occurred between these two observations.
G.M.Brow

POSSIBLE LONG-RANGE COMMUNICATIONS LINK BETWEEN GROUND AND LOW-ORBITING SATELLITES. See Abstr. 1546

SCINTILLATION COUNTERS IN ROCKETS AND SATELLITES
See Abstr. 1982

PHYSICS

GENERAL

2673 SOME LECTURE DEMONSTRATIONS FOR A PHYSICS COURSE.
N.N.Malov, N.P.Orlova, N.E.Selivanenko and I.I.Fedotov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 2, 375-7 (Jan., 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 1, 167-8 (July-Aug., 1960).

Describes (a) a development of Foucault's pendulum in which the change of direction of direction of swing is seen after 4 or 5 oscillations; (b) a magnetic method of demonstrating Newton's third law of motion; (c) an electrical method of demonstrating the conservation of angular momentum; (d) a development of Lissajous' figures in which the beam of a cathode-ray oscillograph describes an epitrochoid on the screen; (e) a demonstration that crown glass is opaque to X-rays; (f) a demonstration that the magnetic field inside a hollow cylindrical conductor is zero; and (g) a model of Stern's experiment on molecular beams. N.Corcoran

2674 UNDERGRADUATE COLLEGE PHYSICS RESEARCH AND ITS SPONSORSHIP. W.H.Kruschwitz.
Amer. J. Phys., Vol. 29, No. 2, 83-5 (Feb., 1961).

Results of a study of more than 100 physics departments in U.S. colleges that offer a major on the baccalaureate level only are reported. One hundred and eight institutions carrying on physics research were located, and a questionnaire was directed to the chairman of each department. Another questionnaire was sent to the chairmen of the physics departments of a selected group of colleges reporting no research being done. It was found that significant research is being done in undergraduate colleges and that it is often designed to allow some participation by the better students in the department. It was further found that more than one-third of the researching departments have part of the work sponsored by an agency outside the school.

2675 COOPERATIVE VENTURE IN THE PHILOSOPHY OF SCIENCE. E.P.Clancy.
Amer. J. Phys., Vol. 29, No. 2, 95-8 (Feb., 1961).

The current trend in the teaching of science, with its increasing emphasis on the broader aspects of physical understanding, demands a deeper appreciation of the structure of science. At present, however, most scientists tend to shun the philosophical implications of their subject, and their students suffer thereby. It is usually the case that only a large university can command the services of a philosopher of science. This article describes a way in which a college found it possible to provide undergraduate training in the philosophy of science, by using cooperatively the services of a philosopher, a physiologist, and a physicist.

2676 RESEARCH PROGRAMS IN NON-Ph.D. GRANTING INSTITUTIONS. J.H.McMillen.
Amer. J. Phys., Vol. 29, No. 2, 108-10 (Feb., 1961).

Research in non-Ph.D. granting institutions in the U.S.A. is increasing. Up to now, the National Science Foundation has made grants to physicists in 60 different institutions of this type. An analysis of these grants shows that physicists in quite small colleges, even those with only two-man departments, engage in research. With research participation becoming more universal, some change in the concept of the college teaching position can be anticipated. It is believed that because of this changing concept and increased research support for small colleges, more of each year's crop of Ph.D.'s will seek teaching positions in these institutions. Increased research activity in non-Ph.D. granting institutions is expected to help them continue their role as an important supplier of well-trained and well-motivated students to the U.S. graduate school system. The research conducted in the small undergraduate school may not be as competitive as that in the large universities, but the research which survives will necessarily be of the challenging type. It is hoped that research programmes in small colleges will not be forced in any way, and that research will not become falsely identified as a cure for bad teaching.

2677 ON MAXIMIZING THE INFORMATION OBTAINED FROM SCIENCE EXAMINATIONS, WRITTEN AND ORAL.
J.R.Platt.
Amer. J. Phys., Vol. 29, No. 2, 111-22 (Feb., 1961).

A written examination is regarded as a "mapping function" to map student abilities onto a numerical scale. The principles of construction for producing maximum information are examined, with somewhat unconventional conclusions about the best gradation and scoring of problems. Increased length t of an exam probably decreases the errors of discrimination between students no faster than $t^{-1/2}$ at best. An oral examination is regarded as a "search path" to locate the boundaries of a student's knowledge. It is less reliable than a written exam partly because of personal biases and fluctuations and partly because an efficient search plan is so rarely agreed upon and followed by oral committee members. Some common pitfalls are listed and some more efficient search procedures are suggested.

2678 INDIAN INSTITUTE OF SCIENCE GOLDEN JUBILEE RESEARCH VOLUME 1909 - 1959.
Bangalore: Indian Institute of Science (1959) 140 pp.

The volume contains 35 papers by the staff and students of the Institute on a variety of subjects. Abstracts of some of these will be found elsewhere in this or succeeding issues of Physics Abstracts.

GRAVITATION . RELATIVITY

2679 THE CLASSICAL FIELD THEORY OF MATTER AND ELECTRICITY. I. AN APPROACH FROM FIRST PRINCIPLES. S.R.Milner.
Phil. Trans A (GB), Vol. 253, 185-204 (Nov. 17, 1960).

The most desirable classical field theory of the fundamental continuous substratum of matter, from which one can imagine particles are formed, would generally be considered to be the electromagnetic equations but for the fact that these are not consistent with the permanent existence of electrons Instead of attempting (as has been usual) to modify the equations by special assumptions for the purpose, the problem is attacked here by deriving from first principles field equations which represent conserved matter; for the failure of the standard equations can be traced to the fact that they do not admit conservation of energy and momentum in general, but only in simple cases. The new equations are found to be identical with those of standard electromagnetic theory except that they contain two extra variables, which indicate the existence of additional energy, momentum and stress in the field. The two variables, however, come into the equations in a way which allows them to be included in the charge and current terms, so that they become there concealed and leave the form of the equations virtually unchanged. Consequently they do not affect the ordinary practical use which is made of the electromagnetic equations; they only come into open play in fundamental theory and in the presence of charge and current in the field, and there they remove the difficulties which the electromagnetic field theory in its accepted form presents.

2680 THE CLASSICAL FIELD THEORY OF MATTER AND ELECTRICITY. II. THE ELECTROMAGNETIC THEORY OF PARTICLES. S.R.Milner.
Phil. Trans A (GB), Vol. 253, 205-26 (Nov. 17, 1960).

The electromagnetic field theory developed in Pt I is here applied to the problem of devising systems which behave as classical particles. It is found that spherically symmetrical systems can exist which, when they are stationary: (1) satisfy the static form of the extended equations at every point of space; and (2) are characterized mechanically by being everywhere in equilibrium under the sole action of the Maxwellian stress of their own field - thus they are pure electromagnetic systems subsisting free of external constraint. (3) When they are transformed so as to be in motion, the energy and momentum they possess are exactly those required for material particles by relativity theory. A rather obvious restriction made on the generality of the conditions for particle existence brought to light the possibility of a solution denoting an "atomic" system built up of successive shells, each of which must contain the same energy, and net charge, as the others. The reason for such a result is that, when their very great generality is restricted in the most straightforward way, the field equations reduce to the form of a wave equation. The relation of this to the wave equation of modern theory is briefly discussed. The transformation behaviour of the field equations when a Lorentz transformation is applied to the co-ordinates is dealt with in this paper; it is found that they remain invariant in form under wider transformations of the field variables than are permitted by the classical equations. The variables may be submitted to a certain transformation without the co-ordinates being transformed at all. The physical meaning of this is investigated and an explanation of it found.

E.M.WAVE PROPAGATION IN A SIMPLE FLUID. RELATIVISTIC THEORY. See Abstr. 3056

2681 GRAVITATIONAL RADIATION DAMPING.
C.M.De Witt and J.L.Ging.
C.R.Acad. Sci. (France), Vol. 251, No. 18, 1868-70 (Oct. 31, 1960). In French.

The metric tensor is separated into a background part satisfying the vacuum field equations everywhere, and a variation $\delta g_{\mu\nu}$ obeying certain coordinate conditions, and satisfying the vacuum equations except on the world-lines of particles, where it becomes singular. The field equations $G^{\mu\nu} + 8\pi Gc^{-4}T^{\mu\nu} = 0$ are expanded in powers of $\delta g_{\mu\nu}$. The authors give the result of a "long but unambiguous" calculation following Dirac's energy balance method for the electromagnetic case (Abstr. 3660 of 1938): in the second approximation, the equation of motion of a mass m in a gravitational field is

$$m_0\ddot{z}^\alpha + (11/3)\, G\, m_0^2 c^{-3}(\dddot{z}^\alpha - c^{-2}\ddot{z}^2\dot{z}^\alpha) + V^\alpha = 0.$$

Here m_0 is the observed mass and V^α a function of the two-point Green's tensor (cf.Abstr. 8538 of 1960). The dots denote absolute derivatives. In the authors' view, the presence of the term V^α precludes the drawing of hasty conclusions from the unexpected + sign (opposite to the electromagnetic case) in front of the preceding term. F.A.E.Pirani

2682 ON THE MOTION OF A PARTICLE IN THE THEORY OF THE SPIN GRAVITATIONAL FIELD. M.Lenior.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2303-4 (Nov. 21, 1960). In French.

Hamiltonian densities of the form $H_{p\lambda}\sqrt{(-g)}g^{p\lambda} + \mathcal{L}$, where the $H_{p\lambda}$ depend only upon the coefficients of connection $\Gamma^\gamma_{\alpha\beta}$ and their first derivatives, and $\mathcal{L}$ is a scalar density independent of the $\Gamma^\gamma_{\alpha\beta}$, are shown to provide conservation equations for the energy-momentum tensor. The equations of motion of a test particle are derived from the field equations. The trajectories of a non-spinning particle with symmetric energy-momentum tensor are shown to be geodesics of the symmetric metric $h^{\mu\nu} = g^{(\mu\nu)}$. R.A.Newing

2683 GENERAL RELATIVITY AND LORENTZ-INVARIANT THEORIES OF GRAVITATIONS.
G.J.Whitrow and G.E.Morduch.
Nature (GB), Vol. 188, 790-4 (Dec. 3, 1960).

Compact summaries of a variety of Lorentz-invariant theories of gravitation (scalar, vector, and tensor), and comparison of their predictions with those of general relativity for (i) classical tests: perihelion advance, deflection of light, red shift; (ii) two-body system: acceleration of mass centre, advance of periastron; (iii) rotation of central body: additional perihelion advance, orbital precession. No Lorentz-invariant theory considered predicts all these effects in complete agreement with general relativity [but not all differences are testable with present technology] .
F.A.E.Pirani

2684 EXACT SOLUTIONS OF THE EINSTEIN–MAXWELL EQUATIONS. W.B.Bonnor.
Z. Phys. (Germany), Vol. 161, No. 41, 439-44 (1961).

It is shown how to generate solutions of these equations from static solutions of $R_{\alpha\beta} = 0$. Classes of electromagnetic solutions, generalizing ones already known, are obtained. There is a close formal similarity between magnetostatic solutions, and those referring to rotating matter. Solutions referring to cylindrically symmetric combined electromagnetic and gravitational waves are also given.

2685 REGARDING THE OBSERVATION OF THE LORENTZ CONTRACTION ON A PULSED RADAR SYSTEM.
C.W.Sherwin.
Amer. J. Phys., Vol. 29, No. 2, 67-9 (Feb., 1961).

Terrell has shown (Abstr. 2102 of 1960) that a visual or photo-

graphic image of a rapidly moving object subtending a small angle from the point of observation will not show relative distortion in its shape arising from the Lorentz contraction. In contrast to this situation, the author shows that the image of a moving object as presented on the map, plan-position display of a multiple-beam pulsed radar system will show the Lorentz contraction along the direction of its motion, in addition to the distortions caused by finite transit time of light signals.

2686 THE EXISTENCE OF SINGULARITY-FREE SOLUTIONS OF THE GENERAL RELATIVITY FIELD EQUATIONS, WHICH CAN REPRESENT PARTICLE MODELS. II.
A.Papapetrou and H.Treder.
Ann. Phys. (Germany), Ser. 7, Vol. 6, No. 5-6, 311-27 (1960). In German.

For Pt I, see Abstr. 10558 of 1959. Discussion of "globally isolated null surfaces", like the Schwarzschild singularity-surface. A Riemannian space–time containing such surfaces must be topologically incomplete; this incompleteness should be regarded as physically unsatisfactory; even if it is allowed, periodic, singularity-free, asymptotically Minkowskian empty space–times are still (cf. Pt I) excluded by the field equations. F.A.E.Pirani

2687 SPHERICALLY PULSATING PARTICLES AND RADIATION IN GENERAL RELATIVITY. J.Hély.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2300-2 (Nov. 21, 1960). In French.

The metric $g_{\alpha\beta} = \delta_{\alpha\beta} + 2al_\alpha l_\beta$ where $l_\alpha = \partial l/\partial x^\alpha$ and a is a function of x^α is considered in the special case when $l = r + ix^4$, $r^2 = (x^1)^2 + (x^2)^2 + (x^3)^2$ and $a = a(r,l)$. One obtains a solution representing a pulsating particle of constant charge whose mass is turning into radiation and back again. C.W.Kilmister

2688 SPINNING CHARGED TEST-PARTICLES IN GENERAL RELATIVITY. A.Das.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 610-15 (April, 1960).

Equations of motion for charged test-particles in electromagnetic or vector-meson fields are derived from Fock–Papapetrou's method. Equations for spinning charged test-particles are obtained in a general covariant way.

2689 A NEW FORM OF THE GEODESIC LINE EQUATION. L.Infeld.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 8, 559-61 (1960).

Let ξ^α be 4 coordinates, ξ^0 time-like, and define $t = \xi^0$, $d\xi^\alpha/dt = \dot{\xi}^\alpha$, (so that $\dot{\xi}^0 = 1$). It is shown that the equations of non-null or null geodesics are

$$\frac{d}{dt}(\mu\dot{\xi}^k) + \mu\left\{{k \atop \alpha\beta}\right\}\dot{\xi}^\alpha\dot{\xi}^\beta = 0,$$

(k = 1, 2, 3) with the additional condition

$$\mu^2 g_{\alpha\beta}\dot{\xi}^\alpha\dot{\xi}^\beta = m_0^2,$$

where m_0 is the proper-mass or zero in the two cases. As well as making the two cases more similar, this formulation has the advantage of using one parameter t for all particles. C.W.Kilmister

2690 CONSTANT ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. R.Debever and M.Cahen.
C.R. Acad. Sci. (France), Vol. 251, No. 11, 1160-2 (Sept. 12, 1960). In French.

Assumptions: the Maxwell–Einstein equations, with a Maxwell field $a_{\lambda\mu}$ whose covariant derivative is a vector multiple of itself. Results: (1) non-singular fields: a and its dual *a have no common direction, and each is covariant constant. Space-time must be conform-Minkowskian. The solutions are those of Bertotti (Abstr. 2111 of 1960) and Robinson (Abstr. 37 of 1960). (2) Singular fields: a and *a have a common null direction. The Weyl tensor is Petrov type III or lower. The Maxwell–Einstein equations reduce to a single partial differential equation, of which solutions, including all the conform-Minkowskian solutions, are exhibited. The vacuum solutions include plane-fronted waves. F.A.E.Pirani

2691 HARMONIC APPROXIMATION AND QUANTIZATION C THE ROSEN METRIC. P.Droz-Vincent.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2297-9 (Nov. 21, 1960). In French.

The Rosen cylindrical metric is written in Bondi's form

$$ds^2 = dt^2 - dx^2 - dy^2 - dz^2 + 2\beta'\{(ydy - zdz)du - (y^2 - z^2)\frac{du^2}{u}\}$$

$$-\beta'^2(t^2 - x^2)\,du^2,$$

where β is a function of u only. It is shown that $g^{\mu\alpha}_{,\mu} = \mathfrak{F}^\alpha$ is of the second order so that Bondi's coordinates are approximately harmonic. An application is made to quantization. C.W.Kilmister

2692 USE OF AN ARTIFICIAL SATELLITE TO TEST THE CLOCK "PARADOX" AND GENERAL RELATIVITY.
W.Davidson, S.F.Singer.
Nature (GB), Vol. 188, 1013-14 (Dec. 17, 1960).

Singer (Abstr. 1042 of 1957) proved that a clock on a satellite in a circular orbit of radius (h + R) round the earth (radius R) suffers a red shift of

$$\tfrac{1}{2}gR(1 - 2h/R)^{1/2}(1 + h/R)^{-1/2}$$

(where c = 1), so providing a possible test of general relativity. The author finds the same result as Singer in a more obviously invariant manner, without introducing an observer at rest at a grea distance. He also notes that the test is actually of the principle of equivalence together with some features of the Schwarzschild metr which might have been predicted by Newtonian gravitation. In a short reply Singer agrees with the result but argues that his metho is physically equally valid. C.W.Kilmiste

2693 NOTES ON THE UNIFIED FIELD THEORY. J.Pachner.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 7, 471-6 (1960).

A unified field theory for gravitation and electromagnetism wit variational principle

$$\delta\int g^{\mu\nu}(R_{\mu\nu} + 2(\dot{L}_{\mu,\nu} - L_{\nu,\mu}) + g_{\mu\nu})d\tau = 0,$$

where $R_{\mu\nu}$ is the contracted curvature tensor of a connection and L_μ is a covariant vector. The theory coincides with the Einstein– Maxwell theory except very near to sources. C.W.Kilmiste

2694 ON A MODIFIED FIVE-DIMENSIONAL THEORY AVOIDING CERTAIN DIFFICULTIES IN THE JORDAN–THIRY THEORY. H.Leutwyler.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2292-4 (Nov. 21, 1960). In French.

The Jordan–Thiry unified field theory suffers from the disadvantages that the field of a neutral particle gives an advance of perihelion different from that observed by a factor 5/4, and that the Lorentz force only arises in conjunction with an unobserve term which is much larger. By using the fact that the theory is only invariant under a sub-group of all transformations in five dimensions the author is able to choose a variational principle whi leads to equations avoiding these difficulties. C.W.Kilmist

2695 ON THE IDENTITIES AND CONSERVATION LAWS IN THE JORDAN–THIRY THEORY. A.Surin.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2295-6 (Nov. 21, 1960). In French.

It is shown that the five-dimensional conservation laws are equivalent to the four-dimensional ones which would be derived by first deducing the four-dimensional identities from the five dimensional ones. C.W.Kilmiste

2696 RELATIVISTIC ROTATORS AND BILOCAL THEORY. D.Bohm, P.Hillion, T.Takabayasi and J.P.Vigier.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 496-511 (March, 1960)

The notion of relativistic or "particle" rotator, which is the system of four "beingrössen" centred on a moving point in Minkowski space has recently been introduced to describe kinematically the average motion of extended particles in space time. Here this system is studied further its similarity with the bilocal theory introduced by Yukawa is pointed out. The special example

of the hyperspherical rotator is treated in detail by replacing the original beingrössen variables with complex triad variables and relativistic Euler angles.

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

2697 QUANTUM MECHANICS IN CURVED SPACE-TIME. S.P.Misra.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 1-16 (Jan., 1960).

A set of equations for elementary particles when the space is curved is obtained by substituting the curved space metric for the flat space one in the algebraic relationship that determines the matrices which describe these particles. It is observed that for the Dirac or Duffin–Kemmer matrices, the same set of equations are obtained if one assumes that the flat space equations are true in the local frame of reference at any point. The above is taken as a fundamental postulate. The approximate corrections to the different fields when the curvature is small are obtained. It is also observed that this procedure means a redefinition of the affine relationship. It is assumed throughout that the curvature is introduced in the space-time world due to the presence of matter by the standard relationship of general relativity.

2698 MEASUREMENT IN QUANTUM MECHANICS. H.Wakita.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 32-40 (Jan., 1960).

If any two states in quantum mechanics are superposed, they interfere with each other. When two states different from each other in a great many degrees of freedom are superposed, the interference effect becomes obscure. If they are different in an infinite number of degrees of freedom, they do not interfere at all, and their superposition is nothing but a mere probability function. This assertion explains how the probability amplitude for a microsystem is converted into a probability function for a measuring apparatus in the course of measurement.

2699 STOCHASTIC DYNAMICS OF QUANTUM-MECHANICAL SYSTEMS.
E.C.G.Sudarshan, P.M.Mathews and J.Rau.
Phys. Rev. (USA), Vol. 121, No. 3, 920-4 (Feb. 1, 1961).

The most general dynamical law for a quantum mechanical system with a finite number of levels is formulated. A fundamental role is played by the so-called "dynamical matrix" whose properties are stated in a sequence of theorems. A necessary and sufficient criterion for distinguishing dynamical matrices corresponding to a Hamiltonian time-dependence is formulated. The non-Hamiltonian case is discussed in detail and the application to paramagnetic relaxation is outlined.

2700 ON THE CALCULATION OF THE EIGHT SPINORS OF SECOND RANK WHOSE COMPONENTS ARE INVARIANT UNDER GENERAL LORENTZ TRANSFORMATIONS. J.Winogradzki.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 1983-5 (Nov. 7, 1960). In French.

2701 EXTENSION OF A LAGRANGE FORMULA TO SOME EIGENVALUE PROBLEMS. J. des Cloizeaux.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 321-46 (Nov. (2), 1960). In French.

An implicit eigenvalue equation may be transformed into an ordinary eigenvalue problem by generalizing the Lagrange formula to operators. A method is given to build a constant operator h which has the same eigenvalues and eigenvectors as the original equation. Moreover it is possible to find a Hermitian operator K which has the same eigenvalues and whose eigenvectors are related in a simple way to the original ones. The method is applied to the calculation of perturbation expansions for bound states starting from the Brillouin–Wigner formula. In this case, the eigenvectors of K have a simple geometric meaning and may be considered as good unperturbed wave functions.

2702 A GENERALIZATION OF THE SCHRÖDINGER EQUATION OF WAVE MECHANICS. J.Picht.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961). p. 7-21. In German.

An absorptive term is added. W.A.Hepner

2703 STUDY OF A CLASS OF POTENTIALS PERMITTING THE SOLUTION OF SCHRÖDINGER'S EQUATION BY ITERATION. H.Cornille.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2135-7 (Nov. 14, 1960). In French.

The iteration method of Abstr. 2499 of 1960 is extended to waves with $l > 0$; by means of Hankel function transformations it is shown that the potential $\exp(-ar)/r^p$, where p is an integer and $a > 0$, allows the method to be used. J.Hawgood

2704 APPLICATION OF THE ITERATION SOLUTION OF THE SCHRÖDINGER EQUATION TO A CLASS OF POTENTIALS. H.Cornille.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2308-10 (Nov. 21, 1960). In French.

The study described in Abstr. 2703 of 1961 is extended to more general potentials, and an explicit kernel is obtained for an exponential potential. J.Hawgood

2705 QUANTIZATION, STATIONARITY AND NON-LINEARITY.
J.Andrade e Silva, F.Fer, P.Leruste and G.Lochak.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2305-7, (Nov. 21, 1960). In French.

It is maintained that the possibility of a Fourier integral representation of a stationary system implies quantization of the frequency spectrum, and that the constancy of the associated relative amplitudes implies a nonlinear theory. R.A.Newing

2706 BOUNDS ON LOW-ENERGY SCATTERING PARAMETERS. L.Spruch and L.Rosenberg.
J. appl. Phys. (USA), Vol. 31, No. 12, 2104-11 (Dec., 1960).

Some recent results that determine an upper bound on the scattering length, whether or not composite bound states exist, are reviewed. The extension to the determination of an upper bound on $(-k\cot\eta)^{-1}$, where only only channel is open, is presented; the method used requires that the potential vanish identically beyond some given point. The results are applicable to the scattering of one compound system by another. Possible extensions and improvements of the method are discussed.

2707 PHASE-SHIFT METHOD FOR ONE-DIMENSIONAL SCATTERING. A.H.Kahn.
Amer. J. Phys., Vol. 29, No. 2, 77-80 (Feb., 1961).

The phase-shift method is developed for the problem of the scattering of a one-dimensional wave by a symmetric potential. Reflection and transmission coefficients are expressed in terms of the phase shifts of odd and even solutions of the Schrödinger equation in the asymptotic range. Integral equations are established for the phase shifts and some approximate methods investigated.

STATISTICAL MECHANICS TRANSFER PROCESSES

2708 A GENERALIZED RECIPROCITY PRINCIPLE [G.R.P.]. L.M.Biberman and B.A.Veklenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 88-93 (July, 1960). In Russian.

A g.r.p., of which several expressions previously obtained by other authors are special cases, is established for the case when the radiation frequency changes during the transfer process. Conditions of validity of the principle are obtained: in particular, the medium must in general be isothermal. By considering certain special cases, the relation between the g.r.p. and the concept of thermodynamic equilibrium is established. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 1, 64-8 (Jan., 1961)]. G.A.Chisnall

2709 TURBULENT DIFFUSION IN TWO AND THREE DIMENSIONS BY THE RANDOM-WALK MODEL WITH MEMORY. R.C.Bourret.
Canad. J. Phys., Vol. 39, No. 1, 133-40 (Jan., 1961).

A lattice model used for the derivation of the telegraph equation for diffusion is extended to two and three dimensions. Appropriate generalizations of the telegraph equation are obtained. These equations give a fine-grained chronological description of diffusion. From these equations, the velocity autocorrelation functions of the diffusing particles are obtained.

2710 RANDOM WALK ON A SPHERE AND ON A RIEMANNIAN MANIFOLD. P.H.Roberts and H.D.Ursell.
Phil. Trans A (GB), Vol. 252, 317-56 (March 31, 1960).

A random walk on a sphere consists of a chain of random steps for which all directions from the starting point are equally probable, while the length α of the step is either fixed or subject to a given probability distribution $p(\alpha)$. The discussion allows the fixed length α or given distribution $p(\alpha)$, to vary from one step of the chain to another. A simple formal solution is obtained for the distribution of the moving point after any random walk; the simplicity depends on the fact that the individual steps commute and therefore have common eigenfunctions. Results are derived on the convergence of the eigenfunction expansion and on the asymptotic behaviour after a large number of random steps. The limiting case of diffusion is discussed in some detail and compared with the distribution propounded by Fisher (Abstr. 5229 of 1953). The corresponding problem of random walk on a general Riemannian manifold is also attached. It is shown that commutability does not hold in general, but that it does hold in completely harmonic spaces and in some others. In commutative spaces, complete analogy with the method employed for a sphere is found.

A PRACTICAL MANUAL ON THE MONTE CARLO METHOD FOR RANDOM WALK PROBLEMS. See Abstr. 2585

2711 ON A GENERALIZATION OF PEIERLS' THEOREM. J.Czerwonko.
Bull. Acad. Polon. Sci. Ser. sci. math. astron. phys. (Poland), Vol. 7, No. 11, 699-701 (1959).

This paper gives a generalization of the theorem of Peierls on lower bounds of the quantum partition function and also gives the appropriate extension of the Bogolyubov variational method.
J.Goldstone

2712 A NOTE ON THE SOLUTION OF THE FOKKER–PLANCK EQUATION FOR THE HARMONIC OSCILLATOR. J.Higgins.
Bull Acad. Roy. Belgique Cl. Sci., Vol. 46, No. 5, 385-9 (1960).

The solution found previously by means of Fourier transforms (Abstr. 9019 of 1957) is obtained more directly. J.Hawgood

2713 EIGENVALUES OF DENSITY MATRICES. B.C.Carlson and J.M.Keller.
Phys. Rev. (USA), Vol. 121, No. 3, 659-61 (Feb. 1, 1961).

For a system of N identical particles in a pure bound state, the density matrices of positive orders p and N–p have the same non-zero eigenvalues with the same multiplicities. If the number of non-zero eigenvalues is finite, these density matrices are unitarily equivalent.

2714 THE COMPENSATION PRINCIPLE AND THE SELF-CONSISTENT FIELD METHOD. N.N.Bogolyubov.
Uspekhi fiz. Nauk (USSR), Vol. 67, No. 4, 549-80 (April, 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2(67), No. 2, 236-54 (March-April, 1959).

The principle of compensation of dangerous diagrams is developed in its general form for a system of fermions, and it is shown that the equations are identical with those obtained earlier by the generalization of Hartree–Fock theory. This is used to obtain the usual equations of superconductivity theory. The generalized time-dependent Hartree–Fock theory is then developed, and the equations are written down for electrons in an electromagnetic field. The theory is reformulated in such a way that particle conservation is never ignored; to do this it is necessary to go one stage further in the approximation scheme. Collective oscillations are found as small-amplitude solutions of the time-dependent equations, and an expression is obtained for the effect of an external perturbation. It is shown that a neutral superfluid system has a quasi-acoustic spectrum, and that the plasma frequency of a charged system is unchanged by the occurrence of superconductivity. The problem of the gauge invariance of superconductivity theory is discussed, and a gauge invariant explanation of the Meissner effect is given.
D.J.Thouless

2715 TEMPERATURE EFFECTS IN THE PLASMA OSCILLATIONS OF A HIGH DENSITY FERMI GAS. I.V.Trosnikov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1347-50 (Dec. 21, 1960). In Russian.

The dispersion formula for the plasma mode is derived in its general form. The first two terms in the low-temperature and the high-temperature expansions are worked out. The classical limit of the formula is found. [English translation in: Soviet Physics—Doklady (USA)]. D.J.Thouless

2716 A FORMAL THEORY OF COLLECTIVE BEHAVIOR. K.Hiroike.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 41-60 (Jan., 1960).

The method of auxiliary variables is generalized so as to be applicable to systems having strong interparticle interactions or obeying Fermi–Dirac statistics. The ground-state energy and the excitation energy spectrum are calculated to the zeroth approximation. It is shown that Feynman's relation for liquid helium and Tomonaga's expression for a one-dimensional Fermi gas can be derived as the special cases of the present theory. The theory is also applied to classical statistical mechanics.

2717 EXTENSION OF THE VARIATIONAL METHOD FOR HARD-SPHERE BOSONS. R.J.Drachman.
Phys. Rev. (USA), Vol. 121, No. 2, 643-8 (Jan. 15, 1961).

The coordinate-space variational treatment for the hard-sphere boson gas developed by Aviles (Abstr. 1100 of 1959) and Iwamoto (Abstr. 11852 of 1959; 14529 of 1960) is extended to include the first logarithmic term in the ground-state energy expansion. The result agrees, within 4%, with the exact results of Wu (Abstr. 899 of 1959) and others. The form of the variational wave-function used is discussed and compared with that obtained using the pseudopotential method of Lee, Huang, and Yang (Abstr. 6893 of 1957

2718 BOUNDARY CONDITIONS IN THE METHOD OF SPHERICAL HARMONICS. V.S.Vladimirov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1091-4 (Dec. 11, 1960). In Russian.

A discussion of the application of a variational method [Izvestiy Akademii Nauk SSSR, Seriya matematicheskaya, Vol. 21, 3, 681 (1957), to the determination of the conditions at the boundary between a medium and a vacuum. [English translation in: Soviet Physics—Doklady (USA)]. J.E.Gor

2719 THE PROBABILISTIC METHOD FOR PROBLEMS OF RADIATIVE TRANSFER. X. DIFFUSE REFLECTION AND TRANSMISSION IN A FINITE INHOMOGENEOUS ATMOSPHERE S.Ueno.
Astrophys. J. (USA), Vol. 132, No. 3, 729-45 (Nov., 1960).

With the aid of the probabilistic method, the exact solutions of the transfer equations for diffuse reflection and transmission of parallel rays by a finite plane-parallel atmosphere of arbitrary stratification are obtained. The solutions are expressed in terms of generalized X- and Y-functions of Chandrasekhar. They are new, except for one of them which has been given by Bellman and Kalaba. While a pair of the scattering and the transmission functions for each of the two boundaries of the atmosphere possesses polarity, the integral equations for those functions are made tractable by means of the reciprocity principle. When the albedo is constant throughout the atmosphere, the solutions reduce to those given by Chandrasekhar. Some diffusion problems with the other boundary conditions are considered and, finally, the diffusely reflected intensity in a semi-infinit inhomogeneous atmosphere is derived. It is equal to the intensity yielded by Sobolev. In an appendix, based on the extension of the Chandrasekhar invariance method, the angular distributions are obtained of the reflected and the transmitted light in a finite plane-parallel inhomogeneous atmosphere illuminated by axially symmetric radiation at the surfaces $\tau = \tau_0$ and $\tau = \tau_1 (\tau_0 \leq \tau \leq \tau_1)$, respectively. The intensities are expressed in terms of four functions: a scattering-transmission pair for each of the two boundaries of the atmosphere, because of their polarity. Half the integral equations for the above functions correspond to the functional relations for the reflectance and transmittance operators given by Preisendorfer. For Pts IX and XI, see Abstr. 14551-2 of 1960.

2720 NON-CONSERVATIVE RADIATIVE TRANSFER IN A UNIFORM MEDIUM. V.I.Barkov.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 376-85 (Sept., 1960). In Russian.

Gives a solution of the integro-differential equation of radiative transfer by means of finite sums used in place of integrals. The method is equivalent to the spherical-harmonics approach and it gives rapid conversions in low-order approximations. Derives general expressions for the mean intensity and the radiation flux in the n-th approximation. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 195-200 (Sept., 1960)].

A.Tybulewicz

2721 LIKELIHOOD DETECTION OF SMALL SIGNALS IN STATIONARY NOISE. P.Rudnick.
J. appl. Phys. (USA), Vol. 32, No. 2, 140-3 (Feb., 1961).

An approximation to the likelihood ratio which may be used in detecting a small signal in stationary noise is derived. The result contains only low-order moments of the signal and only stationary properties of the noise; hence it is applicable without change of form to any sufficiently long observation period. In the Gaussian case, with the signal also stationary and both signal and noise power spectra continuous, the result represents passage through a linear Eckart filter, followed by square law detection and equal-weight smoothing.

GENERAL MECHANICS

2722 THE CHOICE OF SIGN FOR FORCE AND VELOCITY IN THE CASE OF THEIR REPRESENTATION BY EQUIVALENT ELECTRICAL DIAGRAMS. W.Reichardt and A.Lenk.
Acustica (Internat.), Vol. 9, 251-5 (1959) [= Akust. Beihefte, No. 1, (1959)]. In German.

In the design of equivalent electric circuits of mechanical systems certain sign conventions are necessary. Such conventions are in common use in electrical engineering and the present paper makes similar proposal for the mechanical variables particle velocity v and force F. Special emphasis is laid on getting the rules as close as possible to those applicable in electrical engineering. The analogy force — current and velocity — voltage is used.

MECHANICAL MEASUREMENTS

DIGITAL MEASUREMENT AND AUTOMATIC RECORDING OF LINEAR OR ANGULAR POSITION. See Abstr. 2583

AN INSTRUMENT FOR MEASURING ANGLES ON CURVED PHOTOGRAPHIC PLATES. See Abstr. 2590

PNEUMATIC GAUGES FOR IN-PILE MEASUREMENTS. See Abstr. 2269

2723 ULTRASONIC METHOD FOR MEASURING THE HEIGHT OF THE LIQUID LEVEL IN A VESSEL BY MEANS OF FLEXURAL OSCILLATIONS OF A THIN ELASTIC STRIP. N.S.Ageeva.
Akust. Zh. (USSR), Vol. 6, No. 1, 120-1 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 1, 116-17 (July-Sept., 1960).

A method is described for measuring changes in liquid level; it is based on the principle that the phase difference of waves reflected from the end of a thin elastic strip depends of the depth of the strip in the fluid. Using an Al strip of dimensions $930 \times 15 \times 1.5$ mm immersed in water, the phase difference is about 10^0 per 1 mm variation in water level. H.J.H.Starks

2724 GAGING GAS DENSITY WITH FAST CHARGED PARTICLES. B.W.Schumacher.
Nucleonics (USA), Vol. 18, No. 10, 106, 109, 114 (Oct., 1960).

Scattering, energy loss, ionization, or fluorescence can all be used for gas density measurement. Attenuation gauges (combining scattering and energy loss) can be built using β-rays, low-energy electrons or α-rays and will measure density—distance products in the range 1 to 10^{-6} g/cm^2. Fluorescence from gas excited by high-intensity low-energy electron beams can be used to measure local densities, flow speeds and temperatures. For very low pressures systems detecting particles resulting from a single scattering in the gas appear most promising. R.D.Smith

CAPACITIVE ACCELEROMETERS WITH OPTIMUM FREQUENCY-RESPONSE CHARACTERISTICS. See Abstr. 2813

2725 A SIMPLE MANOMETER FOR PRESSURE MEASUREMENTS IN A SMALL CONFINED SPACE. R.Galun and S.Dickstein.
Lab. Pract. (GB), Vol. 9, No. 12, 862 (Dec., 1960).

The manometer described is suitable for use in a desiccator during respiration measurements on insects. The pressure changes are measured by the deflection of a membrane, and sensitivity is changed by altering the thickness of the membrane.

E.G.Knowles

2726 FREQUENCY MEASUREMENT OF STANDARD FREQUENCY TRANSMISSIONS. S.N.Kalra.
Canad. J. Phys., Vol. 39, No. 1, 228 (Jan., 1961).

Lists measurements made at Ottawa, Canada, using N.R.C. caesium-beam frequency resonator as reference standard (with an assumed frequency of 9 192 631 770 c/s). Frequency deviations from nominal are quoted in parts per 10^{10}.

2727 ZIG-ZAG OSCILLOSCOPE PRESENTATION OF MILLI-MICROSECOND ACCURACY FOR MICROSECOND TIME INTERVALS. E.G.Leger, D.Nyberg, K.Graf and L.Tardif.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 57-61 (Jan., 1961).

In the study of the interaction of high-explosive detonation waves with metals by the pin technique, it is desirable to obtain time measurements to an accuracy of less than 1 mμsec over a total time interval of 5 μsec. For this purpose, a cathode-ray oscilloscope, displaying the deflection-type event pulses, was converted into a precise time-measuring instrument by a calibrated zig-zag sweep. The record is obtained by single-shot photography of the cathode-ray tube sweep which is triggered by the event to be measured. The calibrated zig-zag sweep is crystal controlled at 2 Mc/s and has superimposed deflection-type time marks, 2 mμsec wide, at 50 mμsec intervals, synchronized with the zig-zag frequency. The apparatus can drive six oscilloscopes simultaneously or in sequence from delayed triggers.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

2728 A BAR VISCOMETER WITH CONICAL ANNULUS. D.Tollenaar.
J. Colloid Sci. (USA), Vol. 15, No. 4, 381-3 (Aug., 1960).

An equation is derived for the mean rate of shear at the wall of the bar of a bar viscometer (Abstr. 6784 of 1955) whose annulus is very slightly conical. R.Schnurmann

2729 THE VISCOSITY OF MACROMOLECULES. L.Andrussow.
J.Chim. phys. (France), Vol. 57, No. 11-12, 952-8 (Nov.-Dec., 1960). In French.

It is shown how the method of real and mean exponents may be used to determine accurately the rate of change of the viscosity of macromolecules with temperature and with molecular weight or degree of polymerization. The dependence of the viscosity of solutions of macromolecules on the concentration may be determined also. The method is illustrated by curves showing the variation of the real reciprocal exponent of temperature ($1/n^*$) relating to viscosity for polyisobutylene and samples of polystyrene of three different molecular weights, and of the real exponent of concentration (ψ^*) relating to viscosity for solutions of polystyrene in benzene and in methyl ethyl ketone. These curves are calculated from previously published experimental results. B.J.Wilson

2730 GRADIENT DEPENDENCE OF INTRINSIC VISCOSITY OF FREELY FLEXIBLE LINEAR MACROMOLECULES. A.Peterlin.
J. chem. Phys. (USA), Vol. 33, No. 6, 1799-1802 (Dec., 1960).

In laminar flow the randomly coiled macromolecule expands nonuniformly. The averaged distances between close-by chain elements increase much slower than those between elements situated far away on the molecular chain. Because the latter move in opposite direction and the former in the same one, yielding a negative and positive contribution respectively to hydrodynamic interaction, the nonuniform expansion results in a much faster decrease of negative terms. As a consequence hydrodynamic interaction first increases with the gradient yielding an initial drop in intrinsic viscosity proportional to the square of the gradient. With persisting coil expansion, however, the positive terms too decrease so far that the viscosity, after reaching a minimum, rises again and eventually surpasses the initial value at zero gradient. The increase is coming to an end when the r.m.s. end-to-end distance approaches the extended length of the molecule.

2731 STABILITY OF FLOW IN A ROTATING VISCOUS INCOMPRESSIBLE FLUID SUBJECTED TO DIFFERENTIAL HEATING. J.Brindley.
Phil. Trans A (GB), Vol. 253, 1-25 (July 28, 1960).

An attempt is made to find a theoretical explanation for the type of flow observed when a liquid is subjected at the same time to rotation and to a horizontal temperature gradient. When the liquid is contained between two concentric cylinders it is known from experiment that two distinct types of flow occur, one in which the motion is in the form of a meridional vortex with the addition of a zonal component, and the other in which the motion exhibits a meandering wave-like pattern. Of vital importance as regards the type of flow is found to be a parameter defined as the Rossby number for the problem, and two sets of critical values of this parameter are found which bound the range over which wave motion is possible. Qualitatively this is in complete agreement with experimental observations, but quantitative results show some discrepancy between theory and experiment.

2732 APPLICATION OF CONFORMAL MAPPING TO VISCOUS FLOW BETWEEN MOVING CIRCULAR CYLINDERS. L.A.Segel.
Quart. appl. Math. (USA), Vol. 18, No. 4, 335-53 (Jan., 1961).

This work shows that conformal mapping provides an effective way to solve certain unsteady two-dimensional perturbation problems involving the flow of a viscous incompressible fluid, in particular flow between moving circular cylinders. If the outer cylinder is considered fixed, the principal motions treated are the slow rotation of a slightly eccentric inner cylinder, and the vibration of an inner cylinder about a slightly eccentric point. Mapping the given circular boundaries (of a cross-section) into concentric circles enables one to solve for the stream function by means of a series. In the first problem, the solution is carried far enough to afford an estimate for convergence. The torque on the inner cylinder and the second order steady streaming are computed, and a necessary re-examination of the meaning of the second concept is given. Various special cases of the second problem are shown to illuminate the concepts of virtual mass and viscous damping. The results for high frequency vibration bear on an experimental paper by Stuart and Woodgate (Abstr. 1604 of 1955) some of the low frequency results on theoretical work by Andres and Ingard (Abstr. 159 of 1954), and by Stokes. Both problems are of general interest in connection with the design of certain control mechanisms, and with experiments on He II.

2733 MOTION OF A VISCOUS LIQUID PAST AN ELLIPSOID. H.G.Venkates.
Phys. of Fluids (USA), Vol. 4, No. 1, 33-9 (Jan., 1961).

A symmetrical flow pattern due to the motion of a viscous liquid past an ellipsoidal body is determined. A unitary treatment of the flow problem is possible in which the pure potential flow, the slow viscous flow and the type of flow postulated in Prandtl theory are seen to be limiting cases of an exact solution. The flow pattern for the case of the sphere and of the elliptic cylinder are derived as special cases. The method consists in extending the equations of hydrodynamics by the introduction of certain fictitious body forces which are eventually made to vanish in the limit.

2734 STABILITY OF PLANE-PARALLEL STREAMS OF IDEAL LIQUIDS. L.A.Díkii.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1068-71 (Dec. 11, 1960). In Russian.

Hydrodynamical stability is usually established by superposing wave-like perturbations upon the flow under consideration. This method is not applicable to non-viscous liquids. An alternative method is developed in which the perturbation is of a type different from plane waves. [English translation in: Soviet Physics-Doklady (USA)]. R.Eisenschitz

2735 ON THE ADIABATIC COUETTE FLOW OF A COMPRESSIBLE FLUID. W.F.Hughes and J.F.Osterle.
Z. angew. Math. Phys. (Switzerland), Vol. 8, No. 2, 89-96 (March 25 1957).

For isothermal flow of fluid between parallel plates, between which there is relative motion, no pressure gradient can occur. This can only happen in fact when one plate is tilted with respect to the other as in a sliding bearing. It is envisaged that the increasing use of air as a bearing lubricant will bring the problem of adiabatic flow and under such conditions a pressure build-up can occur, due to the thermal wedge effect, even if the plates are parallel. If the air speed is high enough this pressure build-up can be large enough to produce a load supporting pressure in a journal or sliding pad bearing. A mathematical analysis of adiabatic flow between parallel plates is made and a set of equations produced which can be used for the solution of practical problems. One example is worked out. T.C.Toye

2736 A NOTE ON THE DRAG OF A SCREEN AT LOW REYNOLDS NUMBER. P.G.Morgan.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1645 (Nov., 1959).

Sawada has reported work on the drag of a lattice of parallel cylinders at low Reynolds numbers (see Abstr. 19176 of 1960). As a check on this work experiments were carried out on the fall of wire gauzes through glycerine contained in a tower. It was found that the area of cross-section of the tower has a profound effect on the rate of fall of a given screen. T.C.Toye

2737 NEW SYSTEM OF DYNAMIC EQUATIONS OF ISOTROPIC TURBULENCE. S.Pantchev.
C.R. Acad. Sci. (France), Vol. 251, No. 18, 1859-61 (Oct. 31, 1960). In French.

A new method of deriving the equations obtained previously by [Reid, Proc. Cambridge Phil. Soc. (GB), Vol. 51, Pt 2 (1955)] T.C.Toye

2738 UNSTEADY MOTION OF AN INFINITE LIQUID DUE TO THE UNIFORM ROTATION OF A SPHERE, r = a. C.D.Ghildyal.
Quart. appl. Math. (USA), Vol. 18, No. 4, 396-9 (Jan., 1961).

2739 SELF-INDUCED VELOCITY ON A CURVED VORTEX. F.R.Hama and J.Nutant.
Phys. of Fluids (USA), Vol. 4, No. 1, 28-32 (Jan., 1961).

By means of examples the distribution of self-induced velocity along a curved vortex is investigated analytically as well as by means of an analogue experiment of the magnetic field of a current-carrying cable. Results verify, at least for these examples, a theorem which was intuitively introduced by Hama in a study of detailed process of boundary-layer transition (Abstr. 5910 of 1957; 921 of 1960); the induced velocity on a curved vortex is largest in the region where the curvature is largest.

2740 WHEEL COCK FOR MICROFLOW OF LIQUIDS. T.D.Bansal and O.N.L.Srivastava.
J. sci. industr. Res. (India), Vol. 19 B, No. 6, 222-3 (June, 1960).

A needle valve with stainless steel pin and water-tight leather washers suitable for a $\frac{1}{8}$ inch water line is described. S.Weintroub

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

2741 EQUILIBRIUM DISTRIBUTION OF ONE COMPONENT BETWEEN TWO LIQUID PHASES. ITS CONNECTION WITH INTERFACIAL PHENOMENA. A.Vignes.
J. Chim. phys. (France), Vol. 57, No. 11-12, 966-79 (Nov.-Dec., 1960). In French.

A three-component system consisting of two immiscible liquids and a capillary-active solute was considered. An expression was derived thermodynamically that is a generalisation of the Duclaux–Traube rule for the capillary activity of a fatty acid at the free surface of an aqueous solution. Experimental confirmation was obtained by a study of the distribution of a fatty acid, such as acetic, propionic, or butyric acid, between water and an organic solvent, where the organic solvents were selected so as to cover a wide range of interfacial tensions. An empirical relationship was established for the partition coefficient of a capillary-active material between two liquid phases. R.Schnurmann

2742 TRANSFER OF MATTER BETWEEN TWO LIQUID PHASES. I. VELOCITY OF MIGRATION OF ONE COMPONENT THROUGH THE INTERFACE BETWEEN TWO PHASES. A.Vignes.
J. Chim. phys. (France), Vol. 57, No. 11-12, 980-90 (Nov.-Dec., 1960). In French.

In a ternary system, such as acetic acid-water-toluene, the transition of one component through the interface was studied. The rate of distribution of the solute was calculated for the case of a simultaneous migration of the three components. In solvent extraction it is the speed of exchange of the sovent molecules which determines the rate of the process. R.Schnurmann

2743 TRANSFER OF MATTER BETWEEN TWO LIQUID PHASES. II. DIFFUSION VELOCITY OF ONE COMPONENT BETWEEN TWO SEMI-INFINITE PHASES. A.Vignes.
J. Chim. phys. (France), Vol. 57, No. 11-12, 991-8 (Nov.-Dec., 1960). In French.

A method is described for establishing contact between a column of an aqueous solution of acetic acid and a column of pure toluene without causing turbulence at the interface. The interfacial resistance corresponded to 400 sec/cm, and the induction period was 30 sec. R.Schnurmann

2744 TRANSFER OF MATTER BETWEEN TWO LIQUID PHASES. III. INFLUENCE OF SURFACE ACTIVE AGENTS ON THE TRANSFER VELOCITY. A.Vignes.
J. Chim. phys. (France), Vol. 57, No. 11-12, 999-1005 (Nov.-Dec., 1960). In French.

With a surface active agent, 0.5% of "Teepol", in water, the rate of extraction of acetic acid by toluene was about three times slower than without the surface active agent. The ratio of the calculated interfacial resistances was 2.9. A similar effect was found by other investigators who studied the absorption of a gas by a liquid, and the rate of evaporation of water in the presence of a monomolecular film of a fatty acid. R.Schnurmann

2745 SAMPLE ASSEMBLY FOR NEUTRON DIFFRACTION STUDIES OF LIQUEFIED GASES.
G.T.Clayton and L.R.Heaton.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1355-6 (Dec., 1960).

A sample cell is described capable of withstanding pressures of the order of 100 atm while producing no intense or complex diffraction pattern of its own. Further, it may be hermetically sealed, is a good thermal conductor, and is fairly transparent to thermal neutrons. The cell is fabricated from a single crystal of aluminium, and can be oriented so that it produces very little diffraction pattern of its own in the region of interest, thus allowing the empty cell correction to be easily made.

2746 NEUTRON DIFFRACTION STUDY OF KRYPTON IN THE LIQUID STATE. G.T.Clayton and LeR. Heaton.
Phys. Rev. (USA), Vol. 121, No. 3, 649-53 (Feb. 1, 1961).

The angular distribution 1.05 A neutrons scattered by krypton in the liquid state at temperatures of 117°, 133°, 153°, 183° and 210°K is reported. By use of a sample cell fabricated from a single aluminium crystal (see preceding abstract) it was possible to obtain diffraction patterns up to the critical temperature and pressure. The scattering curves were Fourier transformed to obtain the radial atomic distribution function at each temperature. The number of nearest neighbours calculated from these distribution functions ranges from 8.5 at 117°K to 4.0 at 210°K at distances ranging from 4.02 to 4.20 A, respectively. A comparison of radial distribution functions from arbitrarily terminated data shows that the ratio of the last zero-atomic-density-maximum position is a function of the amount of intensity data transformed. It also indicates that the width of the bowl of the effective potential in liquid krupton is in approximate quantitative agreement with that of the Lennard-Jones 12:6 potential.

2747 FIRST-ORDER PHASE TRANSITIONS OF SIX NORMAL PARAFFINS AT ELEVATED PRESSURES.
R.R.Nelson, W.Webb and J.A.Dixon.
J. chem. Phys. (USA), Vol. 33, No. 6, 1756-64 (Dec., 1960).

First-order phase transitions were investigated for n-nonane n-dodecane, n-tridecane, n-pentadecane, n-octadecane, and n-tetracosane, at pressures up to 10 kilobars and temperatures up to 135°C. By a modification of standard piezometric techniques, phase-transition pressures, as well as the associated isothermal isobaric volume changes were determined at approximately 25°C intervals. Correlations established between the melting temperatures and the specific volume changes associated with phase transitions and the n-paraffin chain lengths show a strong dependence upon whether the n-paraffin is of odd or even species. This dependence becomes more pronounced at higher pressures. The specific volume, enthalpy, and entropy changes showed no dependence upon chain length at the same melting temperature.

2748 THEORY OF CLASSICAL FLUIDS: HYPER-NETTED CHAIN APPROXIMATION. III. A NEW INTEGRAL EQUATION FOR THE PAIR DISTRIBUTION FUNCTION. T.Morita.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 829-45 (May, 1960).

For Pt I-II, see Abstr. 1416-17 of 1960. The hyper-netted chain approximation proposed in Pt I is reformulated. The formulae in this approximation for the free energy, chemical potential and pair distribution function are rederived. The pair distribution function in this approximation is shown to satisfy a new integral equation, which is compared with that of Yvon, Born and Green. The variational principle for this approximation is given. Errata are given for Pts I and II.

2749 A NEW APPROACH TO THE THEORY OF CLASSICAL FLUIDS. I. T.Morita and K.Hiroike.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1003-27 (June, 1960).

An exact integral equation is found for the pair distribution function. The integral equation is of somewhat different nature from the ones usually found in the theory of classical fluids, in as much as it involves an infinite series. The Helmholtz free energy is expressed as a series expansion which may be more rapidly convergent than the usual one. It is shown that the integral equation can also be derived by means of a variational principle from the expression for the free energy. It is pointed out that the theory of classical fluids may be constructed with a knowledge of the pair distribution function alone, even if a form of the pair interaction potential is not known.

2750 THERMODYNAMIC ANALYSIS OF BINARY LIQUID ALLOYS OF GROUP IIB METALS. III. THE SOLUTIONS OF ZINC, CADMIUM, INDIUM, TIN, THALLIUM, LEAD AND BISMUTH IN MERCURY. O.J.Kleppa.
Acta metallurgica (Internat.), Vol. 8, No. 7, 435-45 (July, 1960).

For previous work see Ibid, Vol. 6, 223, 233 (1958); also Abstr. 9424 of 1957. The heats of solution of seven other group B metals in mercury were determined calorimetrically at 150°over a fairly wide range in composition. The relative partial enthalpies of mercury were derived, and were compared with excess free energies obtained from the literature. Unlike the corresponding alloys of zinc and cadmium, the considered mercury systems show no correlation between the excess enthalpy, the excess entropy and the valence difference between solvent and solute. However, the observed heats of formation seem to reflect the competition between an "electro-negativity" factor, which gives rise to negative terms in the enthalpy, and a "misfit" factor, which gives rise to positive terms.

2751 DIFFUSION IN A LIQUID INDIUM–TIN ALLOY AT THE EUTECTIC CONCENTRATION.
A.Paoletti and M.Vicentini.
J. appl. Phys. (USA), Vol. 32, No. 1, 22-4 (Jan., 1961).

Self-diffusion coefficients for the two tracers In^{114} and Sn^{113} in the liquid alloy indium–tin at the eutectic composition were measured as a function of temperature in the range 200° C-450° C. The customary Arrhenius equation is used to describe the experimental results. For indium as a tracer

$$D = (42.5 \pm 5.7)10^{-5}\exp\left(-\frac{2771 \pm 158}{RT}\right)cm^2/sec,$$

and for tin

$$D = (11.7 \pm 1.7)10^{-5}\exp\left(-\frac{1380 \pm 156}{RT}\right)cm^2/sec.$$

It is possible that the large difference between the two activation energies could be associated with properties of the eutectic composition.

2752 THE MUTUAL DIFFUSION OF LIGHT AND HEAVY WATER. L.G.Longsworth.
J. phys. Chem. (USA), Vol. 64, No. 12, 1914-17 (Dec., 1960).

With the aid of a special diffusion cell and Rayleigh interferometry, the mutual diffusion was measured at 5, 25 and 45° C over the entire range of composition. Paralleling rather closely the fluidity of H_2O–D_2O mixtures, and also the chloride ion mobility therein, the diffusion coefficient exhibits small negative departures from a linear decrease with increasing mole fraction of D_2O. The effect of temperature on diffusion in this system is compared with that of large solutes in aqueous solution.

2753 COMPRESSION OF FLEXIBLE CHAIN MOLECULES IN SOLUTION. R.Simha and J.L.Zakin.
J. chem. Phys. (USA), Vol. 33, No. 6, 1791-3 (Dec., 1960).

The compression of coiling molecules in good solvents at finite concentrations has been previously traced. However, the expressions were evaluated earlier by means of an expansion in the effective pressure acting on a coil. They are now presented in a form appropriate to include the range of reduced concentrations $c/c_0 \geq 1$. As an example volume ratios for polystyrene solutions in toluene are computed. They depend only slightly on molecular weight and amount to a reduction of about 30% in the most probable encompassed volume, at $c/c_0 = 1$.

2754 CRITICAL SOLUTION PHENOMENON IN TWO-COMPONENT LIQUID SYSTEMS. THE SYSTEM WATER–ETHYLENE GLYCOL MONO-ISOBUTYL ETHER.
De F.P.Rudd and B.Widom.
J. chem. Phys. (USA), Vol. 33, No. 6, 1816-19 (Dec., 1960).

The system water–ethylene glycol mono-isobutyl ether was studied in the neighbourbood of its lower critical mixing point, and it was found that the two lines in a Cox–Herington plot have slopes which, to within a small experimental error, are of exactly equal magnitude. The lower critical solution point was found to be at 25.8° C and 30.4 wt.% ether. It is shown that, in an earlier study of this system by Cox and Cretcher, there were probably significant impurities in the ether. A theorem derived by Rice for a one-component fluid is extended to binary systems, and it allows one to conclude from the symmetry of the Cox–Herington plot that, at the critical solution temperature the chemical potential of either component, as a function of composition, has a discontinuous fourth derivative at the critical composition, the discontinuity being a simple reversal of sign.

2755 THE HYDROGEN BOND AND THE PROPAGATION VELOCITY OF SOUND IN LIQUIDS.
A.E.Lutskii and A.N.Panova.
Akust. Zh. (USSR), Vol. 6, No. 1, 126-8 (1960). In Russian. English translation in: Soviet Physics–Acoustics (USA), Vol. 6, No. 1, 123-5 (July-Sept., 1960).

The effect on the velocity of sound of molecular association arising from hydrogen bonds was studied by comparing the behaviour of the isomeric substitutes of a phenol with a stable intramolecular hydrogen bond in the orthoisomer. Propagation in o-, m- and p-nitrophenol and in the nonassociated o-, m- and p-nitroanisole was studied. Association was characterized by an increase in the velocity, the wave impedance and the Rao constant with temperature and a decrease in the adiabatic compressibility and temperature coefficient of the velocity. H.D.Parbrook

2756 ROTARY DISPERSION OF SOME WERNER COMPLEXES. M.Billardon.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2320-2 (Nov. 21, 1960). In French.

Six Werner complexes in aqueous solution have been studied in the range 2500-6000 A using a spectropolarimeter previously described (Abstr. 13198 of 1959). Absorption curves down to 2100 A have also been obtained using a Beckman spectrophotometer. The known results for the first absorption region are confirmed and by comparison of the Cotton effect of the different bands the analogies existing between the different complexes are specified. H.G.Jerrard

2757 ANOMALOUS DISPERSION OF CS_2 AND $CHCl_3$ — THEORETICAL PREDICTIONS. P.Latimer.
J. Opt. Soc. Amer., Vol. 51, No. 1, 116-17 (Jan., 1961).

Equations obtained by Davýdov have been used to calculate absorption and dispersion curves for the 4.640 μ band of CS_2 and the 3.283 μ band of $CHCl_3$. Comparison with experimental curves shows that agreement is good for CS_2 but not for $CHCl_3$; the results do however indicate that the equations provide a reasonable quantitative basis for evaluating dispersion curves. D.L.Greenaway

2758 A COMPARISON OF THE WIDTHS OF LIQUID-PHASE INFRARED ABSORPTION BANDS AND OF THE CORRESPONDING RAMAN BANDS. J.C.Evans.
J. Opt. Soc. Amer. (USA), Vol. 50, No. 12, 1337-8 (Dec., 1960).

Data has been obtained to enable comparison of the widths of infrared bands (grating instrument, slit width 0.5 cm^{-1}) and Raman bands (Hilger recording Raman spectrometer) of a number of molecules in the liquid phase. These appear to be similar, but some highly polarized Raman bands are narrower than the corresponding infrared bands. Reasons for this are discussed. R.C.Seymour

2759 ALLOWANCE FOR THE EFFECT OF INTERNAL FIELDS IN CALCULATION OF RAMAN INTENSITIES.
V.M.Pivovarov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 266-9 (Aug., 1960). In Russian.

A theoretical dependence of the Raman line intensities on the solute concentration and the refractive index of the solvent is derived with allowance for the effect of internal fields. It accounts satisfactorily for the empirical dependence of the Raman line intensities on the solute concentration in the case of CCl_4 and benzene, both dissolved in acetone. [English translation in Optics and Spectrosc. (USA), Vol. 9, No. 2, 139-40 (Aug., 1960)]. A.Tybulewicz

2760 DEPOLARIZATION OF FLUORESCENCE OF LIQUID SOLUTIONS. A.Jabłonski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 9, 655-60 (1960).

Perrin's theory of depolarization of fluorescence of solutions by rotational Brownian motion is extended to allow for molecular torsional vibrations. The theory is compared with measurements on uranin in glycerol and water. J.B.Birks

2761 KINETICS OF CONCENTRATION DEPOLARIZATION OF LUMINESCENCE AND INTERMOLECULAR TRANSFER OF EXCITATION ENERGY.
P.I.Kudryashov, B.Ya.Sveshnikov and V.I.Shirokov.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 341-8 (Sept., 1960). In Russian.

Discusses the ratio $(\tau_\perp - \tau_\parallel)/\tau_0$ for the case of concentration depolarization of fluorescence in solutions; here $\tau_\perp$ and $\tau_\parallel$ are respectively the decay durations (relaxation times) of the components perpendicular and parallel to the electric vector in the exciting light, and τ_0 is the mean relaxation time. The experimental maximum of this ratio (0.12) for fluorescein in glycerine agreed with the Förster–Galanin theory of concentration depolarization. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 177-81 (Sept., 1960)]. A.Tybulewicz

2762 THE CONCENTRATION DEPENDENCE OF LUMINESCENCE SPECTRA OF ORGANIC PHOSPHORS. A.Baczyński and M.Czajkowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 9, 651-4 (1960). In German.

The existence of luminescence centres of different properties is shown for solutions of fluorescein in boric acid. The emission spectra, corrected for absorption and refraction errors, are different for concentrations of 10^{-6} and 10^{-3}, with peaks at 4640 and 4800 A, respectively. Over the same concentration range, the decay of luminescence changes appreciably. S.T.Henderson

2763 SENSITIZED FLUORESCENCE IN SOLUTIONS. B.Ya.Sveshnikov, P.I.Kudryashov and L.A.Limareva.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 203-8 (Aug., 1960). In Russian.

Reports a study of the absorption and luminescence spectra, the yield and duration of luminescence of solutions of rhodamine B and trypaflavine and their mixtures as a function of the dye concentration. At concentrations greater than 2×10^{-4} mole/litre (concentrations of both dyes were equal) excitation energy was transferred in radiationless manner from trypaflavine to rhodamine with a yield close to 0.7. At concentrations greater than 0.02 mole/litre such radiationless transfer was accompanied by quenching of excited rhodamine molecules by trypaflavine. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 107-10 (Aug., 1960)]. A.Tybulewicz

2764 DEPENDENCE OF FLUORESCENCE OF NAPHTHALENE DERIVATIVES ON THE CONCENTRATION OF HYDROGEN IONS IN A SOLUTION. L.D.Derkacheva.
Optika i Spektrosk.(USSR), Vol. 9, No. 2, 209-14 (Aug., 1960). In Russian.

Deals with dependence of the relative luminescence yields of molecular and ionic forms of nine oxy-derivatives of naphthalene in solutions on the concentration of hydrogen ions. The dissociation constants in the ground and excited states were determined, as well as the rates of protolytic reactions. The absorption and luminescence spectra of the nine derivatives were recorded at various pH values of the solutions. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 110-13 (Aug., 1960)]. A.Tybulewicz

2765 RISE-TIME CHARACTERISTICS OF ORGANIC SOLUTION SCINTILLATORS.
D.F.McDonald, B.J.Dunn and J.V.Braddock.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 17-22 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A special demountable cathode-ray tube was designed to produce electron-beam excitation of organic scintillator solutions. Solutions are irradiated through an electron-permeable window. The beam is swept across the window in 0.4×10^{-9} sec. A 1P28 photomultiplier and travelling-wave oscilloscope are used in recording. About 25 000 MeV of excitation energy is delivered per pulse and pulse oscillograms are free of statistical variations. System response time is due almost wholly to photomultiplier transit-time dispersion. A pure Gaussian form is assumed for the response function of the system in analysing pulse contours. The time resolution of the system is adequate to permit observation of the dependence of pulse rise times on concentration in solutions of p-terphenyl in toluene and anthracene in benzene. The results are in good agreement with the energy-transfer theory proposed by Kallmann and Furst (see Abstr. 3491 of 1952).

MOLECULAR LUMINESCENCE AND LUMINESCENCE ANALYSIS. USSR CONFERENCE. See Abstr. 2450

THE SCINTILLATION PROCESS IN ORGANIC SYSTEMS. See Abstr. 2459

ORIGIN OF SCINTILLATIONS IN ORGANIC MATERIALS. See Abstr. 2460

2766 DIELECTRIC BEHAVIOUR OF A TERTIARY LIQUID MIXTURE OF ETHYL ALCOHOL, o-CRESOL AND α-BROMONAPHTHALENE. V.Sarojini.
J. sci. industr. Res. (India), Vol. 19B, No. 3, 115 (March, 1960).

Schallamach (Abstr. 617 of 1948) suggested that the relaxation process in liquid mixtures is not connected with the individual molecules present. However, work on tertiary liquids shows three distinct peaks in the variation of ϵ' and ϵ'' with frequency and temperature. This supports earlier work on binary mixtures, which indicated that each component retains its individual relaxation characteristic. J.H.Mason

2767 THE INFLUENCE OF WATER ON THE CONDUCTIVITY OF DIELECTRIC LIQUIDS. N.Félici.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 953-5 (Aug. 17, 1960). In French.

A further development of the theory put forward in an earlier paper (Abstr. 19136 of 1960) to explain the conductivity found in organic liquids due to impurity water. The electrical energy of an ion in a hydrated liquid is evaluated, taking account of the concentration of water around the ion. A dissociation of water is found which is of the order of magnitude observed in de-ionized liquids and which explains the permittivity-dependent effects of pollution in dielectric liquids. R.G.C.Arridge

2768 ORIENTATION RADIOFREQUENCY SPECTRA OF POLYALCOHOLS. C.Moriamez.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1765-7 (Oct. 24, 1960). In French.

Interpretation is discussed of measurements of complex permittivities (numerical details not given) for several short-chain diols and glycerol, in the liquid phase, over the frequency range 0.01-25 000 Mc/s and the temperature range -40° to $+70^{\circ}$ C. Measurements of viscosity were also made in the temperature interval -20° to $+70^{\circ}$ C. The permittivity at infinite frequency increases sharply as the temperature falls below a value characteristic of the alcohol. An extra domain of dispersion and absorption is distinguished (domain 1b) in which the relaxation mechanism resembles that in domain 1 in that the absorption and dispersion obey the Debye law. The activation energies for dipolar orientation in domains 1 and 1b are equal, and independent of the chain-length for alcohols of a given class, but their value depends on whether the alcohol is bi-primary, primary-secondary or glycerol. These energies also equal the respective energies of activation from the temperature-dependence of viscosity. An interpretation is given, based on association by hydrogen bonds into linear chains, with further hydrogen bonds between chains. Domain 1b results from the partial reorientation of the molecule after fracture of inter-chain hydrogen bonds. J.Sheridan

2769 A STUDY OF THE RELAXATION [BEHAVIOUR] OF A PARAMAGNETIC ION BY MEANS OF DYNAMIC POLARIZATION. A.Landesman and A.Abragam.
C.R.Acad. Sci. (France), Vol. 251, No. 15, 1490-2 (Oct. 10, 1960). In French.

It is shown that the dynamic polarization of protons in an aqueous solution of the paramagnetic ion $NO(SO_3)_2^{--}$, produced by an r.f. magnetic field parallel to a steady magnetic field allows the relaxation processes of the electron spins to be studied and determined unambiguously. S.A.Ahern

MECHANICS OF GASES

2770 INTERACTION BETWEEN A RIGID BODY AND A FREE MOLECULE FLOW. III. RELATIONS BETWEEN THE INTERACTION COEFFICIENTS AND THE TIME OF THE MOLECULE ON THE SURFACE. S.Nocilla.
Atti Accad. Sci. Torino I (Italy), Vol. 94, No. 6a, 782-95 (1959-60). In Italian.

For Pt I-II, See Abstr. 19172 of 1960.

2771 AN APPROXIMATE METHOD FOR THE INTEGRATION OF EQUATIONS OF A NONSTATIONARY LAMINAR BOUNDARY LAYER IN AN INCOMPRESSIBLE FLUID. L.A.Rozin.
Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 5, 615-23 (1957). In Russian.

2772 BOUNDARY-LAYER EQUATIONS AND THEIR BOUNDARY CONDITIONS IN THE CASE OF SUPERSONIC MOTION IN A MODERATELY RAREFIED GAS. Yu. P.Lun'kin.
Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 5, 597-605 (1957). In Russian.

Prandtl's boundary-layer is used to derive equations which differ from the normal Prandtl equations by the presence of additional terms which contain higher velocity and temperature derivatives. The normal pressure gradient differs from zero and is expressed by supplementary terms. Kinetic theory is invoked to establish the boundary conditions, which turn out to be generalizations of Maxwell's (1890) and Smoluchowski's (1899) conditions for supersonic flow. The limits of applicability of the equations, in relation to velocity and height, are given.

2773 APPLICATION OF A METHOD OF SMALL PERTURBATIONS TO PROBLEMS OF LAMINAR BOUNDARY LAYER. V.V.Lunev.
Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 5, 606-14 (1957). In Russian.

The boundary-layer equations are solved of a compressible gas with small pressure gradients, with arbitrary temperature variations of viscosity, and with a variable Prandtl number. Dissociation does not introduce any change into the method of solution. The results are applied to supersonic laminar boundary-layers on slender bodies.

2774 ON A DIFFERENTIAL EQUATION OF BOUNDARY-LAYER THEORY. W.A.Coppel.
Phil. Trans A (GB), Vol. 253, 101-35 (Sept. 8, 1960).

The differential equation

$$y''' + yy'' + \lambda(1 - y'^2) = 0$$

is of importance in boundary-layer theory Weyl (1942) has shown that the equation has a solution which satisfies certain boundary conditions. The present paper gives a simple proof of Weyl's result and then investigates in detail the properties of all solutions of the equation.

2775 INVESTIGATION OF VORTEX [TUBE] TEMPERATURE SEPARATORS FOR COMPRESSED GAS. V.I.Metenin.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 9, 1095-1103 (Sept., 1960). In Russian.

Compressed gas is discharged through nozzles into a tube in such a way that it is given a large tangential component of velocity, resulting in violent rotational movement. Under these conditions the gas separates into a warm and a cold fraction which may be withdrawn separately (Ranque effect). This effect was studied quantitatively using air at pressures of 2-9 atm and temperatures between -140° and $+20^\circ$C. Additional experiments were made with water vapour at 200°C. The influence of the design and measurements of the tube and other parts of the apparatus are assessed. [English translation in: Soviet Physics — Technical Physics (USA), Vol. 5, No. 9, 1025-32 (March, 1961)]. R.Eisenschitz

2776 THE EXISTENCE OF A WEAK SOLUTION OF THE DIRECT PROBLEM IN THE THEORY OF SONIC FLOW PAST A PROFILE IN THE FIRST APPROXIMATION. F.I.Frankl'.
Dokl. Akad. Nauk SSSR, Vol. 132, No. 4, 789-92 (June 1, 1960). In Russian.

The hodograph method is used. By linearizing the boundary conditions, the problem is solved, to a first approximation, for cases which are sufficiently close to that of symmetrical flow round a smooth, symmetrical profile. The existence of a "weak" solution is demonstrated. [English translation in: Soviet Physics—Doklady (USA)]. G.A.Chisnall

Shock Waves

OPTICAL REFRACTIVITY BEHIND SHOCK WAVES IN HYDROGEN–OXYGEN MIXTURES. See Abstr. 2788

2777 CHANGE IN GAS PARAMETERS DURING NON-EQUILIBRIUM DISSOCIATION BEHIND A SHOCK WAVE. Yu.P.Lun'kin.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 6, 622-6 (June, 1960). In Russian.

An approximate method is given for solving the equations which describe the non-equilibrium dissociation of a gas behind a shock wave. [English translation in: Soviet Physics—Technical Physics (USA)]. Z.Krasuck

2778 THE NON-EQUILIBRIUM STATE BEHIND A SHOCK WAVE IN AIR. S.A.Losev and N.A.Generalov.
Dokl. Akad. Nauk SSSR, Vol. 133, No. 4, 872-4 (Aug. 1, 1960). In Russian.

For previous work see Abstr. 19211 of 1960. The high-pressur chamber of a shock tube contained H_2 at 40-130 atm; the low-pressure chamber contained 4.4-7.6 mm Hg of air purified by freezing with liquid nitrogen. The velocity of shock waves (2.4--3.7 km/sec) was measured with ionization probes to an accuracy o 1-2%. Immediately behind the wave-front a considerable absorption of light was observed near $\lambda = 2200$ A; then the absorption decrease and became constant (equilibrium state of the gas). The observed absorption maximum was primarily due to O_2 molecules (transition from the ground state $X^3\Sigma_g^-$ to the state $B^3\Sigma_u^-$). An attempt is made to relate the decrease of absorption to the non-equilibrium dissociation of O_2 in air. F.Lachma

2779 THE STABILITY OF A PARTICULAR CONVERGING SPHERICAL SHOCK WAVE.
R.M.Zaidel' and V.S.Lebedev.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 2, 227-9 (Nov. 11, 1960). In Russian.

The limit of stability is found by perturbation methods. The analytical results are discussed at some length. They are, howeve not given in a form suitable for application to experiments. [Englis translation in: Soviet Physics—Doklady (USA)]. R.Eisenschitz

2780 PROPAGATION OF SHOCK WAVES IN INHOMOGENEO GASES. I. Y.Ôno, S.Sakashita and H.Yamazaki.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 294-304 (Feb., 1960).

Chisnell's method of shock propagation (Abstr. 2745 of 1956) is generalized for the case of inhomogeneous gravitating gases. The relation between shock strength and initial pressure is derived to the first approximation, using a polytropic index as parameter. The strength of a shock wave, which is generated near the centre and progresses outwards, increases rapidly, being proportional to some inverse power of pressure near the surface. Applying the results to the Eddington model, some speculation concerning the origin of nova explosions is made.

2781 MODIFIED DOUBLE SLIT INTERFEROMETER FOR SHOCK WAVE INVESTIGATIONS. G.H.Markstein.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1291-6 (Dec., 1960).

The possibility of applying the Rayleigh double slit interferometer for shock-wave investigation was explored. In common with Rayleigh interferometers currently used for diffusion, electrophoresis, and ultracentrifuge studies, the instrument adapted for the present application contains a cylinder lens for bringing the interference fringes and the test section into simultaneous focus at the camera image plane. However, in contrast to previous applications, it was found desirable in the present work to let the light paths through both slits transverse the test section. This arrangement required a modification which consisted of tilting the axis of the cylinder lens, and the light source slit, with respect to the conventional orientation parallel to the refractive index gradient. Conditions under which a useful interferogram is obtained with this instrument are derived, and results of preliminary experiments ar presented. Compared with the Mach–Zehnder interferometer, the double slit instrument has the advantages of greater simplicity and ease of adjustment, lower cost, and offers the possibility of combining the interferometer with an inclined slit schlieren system

2782 MEASURMENT OF THE STRUCTURE OF STRONG SHOCKS IN HELIUM-FILLED T TUBES.
W.Wiese, H.F.Berg and H.R.Griem.
Phys. of Fluids (USA), Vol. 4, No. 2, 250-3 (Feb., 1961).

The structure of Mach 25 shock waves was investigated spectroscopically. Rise times of 0.20 and 0.15 μsec were observed for the He I 5876 A and the He II 4686 A line, respectively, which are consistent with the expected relaxation times, if one adopts the hypothesis that the ambient gas is substantially pre-excited by u.v. radiation from the discharge. This confirms earlier conclusions from the measured equilibrium conditions ($T \cong 3$ eV, $N_e \cong 2 \times 10^{17}$ cm^{-3}) and suggests that local thermal equilibrium exists in the region behind the shock.

2783 LOW-DENSITY SHOCK TUBE FOR CHEMICAL KINETICS STUDIES. S.C.Lin and W.I.Fyfe.
Phys. of Fluids (USA), Vol. 4, No. 2, 238-49 (Feb., 1961).

Some problems concerning the extension of high-temperature shock tube experiments to low gas densities are discussed. Specific examples are cited on the operation and actual performance of a 24 in. diam shock tube that has been constructed for chemical kinetics studies at gas densities in the neighbourhood of 10^{-5} normal atm (i.e., about 80 km simulated altitude). Some preliminary results on the dissociation and ionization rates, as well as the visible radiation profile, behind strong normal shocks in air ($12 < M_S < 22$) at these low densities are also presented.

2784 OPTICAL STUDY OF A MAGNETICALLY DRIVEN SHOCK TUBE. M.Cloupeau and A.Szaniawski.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 51, 117-121 (June, 1960).

Preliminary experiments upon the propagation of discharge-initiated shock waves in a T tube are reviewed. Rotating-mirror smear photographs of the progress of the incident and reflected shock waves indicate that the excitation of the gas is not entirely thermal. R.W.Nicholls

2785 ELECTRONS AS A SHOCK DRIVER GAS. R.G.Fowler, G.W.Paxton and H.G.Hughes.
Phys. of Fluids (USA), Vol. 4, No. 2, 234-7 (Feb., 1961).

The electric shock tube, below a transition pressure characteristic of the tube diameter and the gas under study, exhibits two clearly distinguishable luminous fronts having the apparent attributes of shocks. The first front is initiated too quickly to be ascribed to a temperature increase of the gas molecules, and seems therefore to depend directly on the electrons and their fields in some way. It is hypothesized that electron pressure is the primary source of this motion. This hypothesis is consonant with the extensive evidence at hand.

2786 USE OF FINE UNHEATED WIRES IN SHOCK TUBES. W.H.Christiansen.
Phys. of Fluids (USA), Vol. 3, No. 6, 1027-8 (Nov.-Dec., 1960).

Reports preliminary experiments which show that the response is nearly exponential with time. It should prove a valuable flow instrument in many short-duration flow problems with a gas of high stagnation enthalpy. J.M.Hough

GASEOUS STATE

2787 ON THE CALCULATION OF SOUND-VELOCITY IN GAS MIXTURES. V.S.Vrkljan.
Nuovo Cimento (Italy), Vol. 17, No. 6, 845-9 (Sept. 16, 1960). In German.

A new derivation is given of the relation for the velocity of sound in a mixture of ideal gases for which the ratio of specific heats and density is known. A formula is obtained which relates these magnitudes with the corresponding values for the individual constituents of the mixture. A.B.Wood

2788 OPTICAL REFRACTIVITY OF HIGH-TEMPERATURE GASES. III. THE HYDROXYL RADICAL. D.R.White.
Phys. of Fluids (USA), Vol. 4, No. 1, 40-5 (Jan., 1961).

For Pt II, see Abstr. 7933 of 1959. The refractive index was measured interferometrically behind Mach 6 to 9 shock waves advancing into nearly equimolal hydrogen and oxygen at pressures of 0.01, 0.015 and 0.02 atm. Pressure measurements in these experiments together with other data on similar systems show the shocked gas to be in an equilibrium state. The refractivity to be expected from all species present, except the hydroxyl radical, is computed, and the difference between this and the observed refractivity is attributed to hydroxyl radical present at the equilibrium density. The resultant specific refractivity in the blue is $K = 0.35 \pm 0.04$ cm^3/g, corresponding to a polarizability of $\bar{\alpha} = 1.5 \pm 0.2$ A^3 and a refractivity of $\mu - 1 = (2.5 \pm 0.3) \times 10^{-4}$.

2789 THEORY OF TRANSLATIONAL ABSORPTION IN GASES. J.D.Poll and J.Van Kranendonk.
Canad. J. Phys., Vol. 39, No. 1, 189-204 (Jan., 1961).

The theory of translational infrared absorption in gases is developed. Invariant expressions for the integrated absorption coefficients are derived. The absorption coefficients are expanded in powers of the density, and the binary absorption coefficients are expressed in terms of a model for the induced pair dipole moments. Monatomic gas mixtures, diatomic gases, and diatomic–monatomic gas mixtures are considered in detail. As an application the binary absorption coefficient of the translational band of hydrogen is calculated.

2790 ELECTRICAL CONDUCTIVITY OF PARTIALLY IONIZED GASES. A.C.Pipkin.
Phys. of Fluids (USA), Vol. 4, No. 1, 154-8 (Jan., 1961).

Transfer equations as given by Burgers are used to calculate the electrical conductivity of a partially ionized gas in the presence of a magnetic field. The result corresponds to what Chapman and Cowling call a "second approximation", taking into account the influence of heat transfer. The importance of various terms occurring in the final expression is analysed.

VACUUM PHYSICS

2791 THE TEACHING OF VACUUM TECHNIQUES. M.Oria.
Vide (France), Vol. 15, 105-8 (March-April, 1960). In French.

A diffusion-pumped vacuum system is described suitable for demonstrating the elements of vacuum techniques and particularly the calibration of various vacuum gauges and the measurement of pumping speed. W.Steckelmacher

2792 DISCUSSING ULTRA HIGH VACUUM. J.Schweitzer.
Vide (France), Vol. 14, 165-82 (July-Aug., 1959). In French and English.

The requirements for ultra-high vacuum are reviewed and the importance of surface phenomena is shown. Factors which limit the degree of vacuum achievable are discussed particularly degassing and vapour pressure of materials, capillary condensation, adsorption, diffusion and permeability. Transfer phenomena are considered in connection with the sticking time of molecules as they come into contact with the walls of a tube. W.Steckelmacher

2793 RECENT DEVELOPMENT OF ULTRA-HIGH VACUUM SYSTEMS USING OIL DIFFUSION PUMPS. W.K.Huber and E.A.Trendelenburg.
Vide (France), Vol. 15, 132-9 (March-April, 1960). In English and French.

A modified Alpert-type ultra-high vacuum system was connected with a bakeable glass mass spectrometer having a partial pressure sensitivity of about 1×10^{-13} mm Hg, as described by Reynolds (Abstr. 2329 of 1957). In agreement with investigations by Lange (1958), which were carried out with a less sensitive instrument, it could be shown that the main constituents of the residual atmosphere are H_2 and CO and that there are no masses higher than 45 detectable as long as the copper trap is not saturated. A metal pump system using a rotary fore pump, a 120 l./sec diffusion pump and a 650 l./sec diffusion pump followed by a bakeable baffle and liquid air trap arrangement was built. A vacuum of about 1×10^{-9} mm Hg could be maintened for 2 weeks without refrigerating the liquid air trap. A hydraulically operated all-metal valve suitable for this system is also described.

2794 ULTRA-HIGH VACUA AND DIFFUSION PUMPS. (INDUSTRIAL PRODUCTION OF A PRESSURE OF 4×10^{-10} torr). J.Amoignon and J.Moreau.
Vide (France), Vol. 14, 344-7 (Nov.-Dec., 1959). In French and English.

The performance of a bakable stainless-steel oil-diffusion-pumped system in which all high-vacuum joints were argon-arc welded was examined. Using a watercooled baffle and a backing diffusion pump operating at lower than 10^{-6} torr a pressure of 3.5×10^{-9} torr was obtained in 50 hours. With liquid nitrogen in the trap the pressure fell to 4.5×10^{-10} torr after a further 28 hours. W.Steckelmacher

2795 A NEW TYPE OF ION PUMP. G.Comsa and G.Musa.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 2, 119-33 (1957). In Roumanian.

A description is given of the working principle and construction of a new type of ion pump, to obtain pressures below 10^{-8} torr. It is based on the idea that in a Bayard–Alpert ion pump the pumping

action is primarily due to adsorption on the glass walls. The principal parts of the pump are a filament and a grid. After a few electrons have reached the glass envelope, it charges to a negative potential approaching that of the filament. It thus becomes a third ion collecting electrode. It can be shown furthermore that a reasonable choice of dimensions and potentials leads to a high pumping speed. There follows a description of the method of measuring pumping speeds. These are about 0.25-0.27 l./sec, i.e. 3-9 times greater than experimental values reported in the literature. Apart from this, the proposed pump has a practical advantage compared with the Bayard–Alpert ion gauge pump. It is easier to make, more rugged and easier to outgas. D.Walsh

2796 A NEW TYPE OF IONIZATION GAUGE.
W.Krauze and W.Gorski.
Przeglad Elektron. (Poland), Vol. 1, No. 1, 84-7 (1960). In Polish.
The ionization gauge control unit is described briefly. It is very similar to one designed by Steckelmacher and Van Der Meer (Abstr. 3431 of 1950). J.M.Zarzycki

GAS DENSITY GAUGES USING FAST CHARGED PARTICLES. See Abstr. 2724

2797 THE RESISTANCE LEAK DETECTOR.
W.Krauze and S.Pytkowski.
Przeglad Elektron. (Poland), Vol. 1, No. 1, 79-83 (1960). In Polish.
Details are given of a resistance leak detector. Using a differential arrangement of the bridge, leaks of 2×10^{-7} torr l./sec were detected. J.M.Zarzycki

2798 ROLLING O-RING SEAL.
P.L.Edwards.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1356 (Dec., 1960).
Describes a seal useful where the chamber pressure is below, or only slightly above, the outside pressure and where convenient acess to the opening is desired.

2799 EXPERIMENTAL STUDY OF METAL GASKETED JOINTS FOR ULTRA-HIGH VACUUM.
J.P.Boulloud and J.Schweitzer.
Vide (France), Vol. 14, 241-9 (July-Aug., 1959). In French and English.
Various designs of joints were evaluated for tightness (at normal temperatures) using a mass spectrometer with helium as search gas. Leaks down to 10^{-13} cm^3 (at s.t.p.)/sec of helium were detectable by an accumulation technique. Joints were compressed by a hydraulic jack. The applied force as well as the degree of compression were measured together with the leak rate obtained. All types of joint tested showed a hysteresis effect in that once a tight joint had been made the compression could be reduced to 100 kg/cm ±20% (except for indium) to maintain tightness. The purity of gasket metals or surface finish appeared to have no effect on leakage but poor surfaces were shown to cause excessive degassing of the joint. Some results are reported for joints cycled up to 450° C. W.Steckelmacher

2800 METALLO-PLASTIC JOINTS IN VACUUM TECHNIQUE.
J.Pierre.
Vide (France), Vol. 15, 381-7 (Sept.-Oct., 1960). In French and English.
Following a general discussion on plastic deformation of metals, demountable metal vacuum joints are considered. For a joint using a hard wedge-shaped metal ridge biting into a flat metal gasket a constant sealing force must be maintained to ensure continued tightness especially after baking to a high temperature. A spring washer of the belleville type is recommended. It should be in a high temperature alloy maintaining spring properties up to 500° C. W.Steckelmacher

2801 A METALLIC AIR-ADMITTANCE VALVE.
M.Rieu.
Vide (France), Vol. 14, 365-6 (Nov.-Dec., 1959). In French and English.
A disk sealing valve of conventional design. It permits glass blowing operations when open. W.Steckelmacher

2802 TRANSISTORIZED VACUUM TRIP UNIT
D.Jones.
J. sci. Instrum. (GB), Vol. 38, No. 2, 51-3 (Feb., 1961).
A vacuum trip unit has been designed, using a thermocouple gauge and a transistorized d.c. amplifier, to operate relays in the interlock and protection circuits of a high-vacuum pumping system. The unit is simple to construct and set up, yet has proved stable and reliable in operation.

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

2803 BASE PRESSURE FLUCTUATIONS.
K.McK.Eldred.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 59-63 (Jan., 1961).
The intense vibration accompanying the extension of dive brakes and other high drag devices on aircraft and missiles has been observed for many years. Recently, considerable vibration has been experienced at the fundamental longitudinal mode and at other internal resonance frequencies of a vehicle which had a blunt base during the maximum dynamic pressure phase of flight. In both cases the vibration is believed to result from the turbulent fluctuations in the wake of the base or drag device. The base pressure fluctuations were measured at two base positions on a small body of revolution at eleven points in the velocity range of 68 to 352 ft/sec. The results show that: (a) the ratio of $(\langle p^2 \rangle_{av}/q^2)^{1/2}$ varies between 0.007 at the centre of the base to 0.015 at 65% radius; (b) the spectrum of the pressure fluctuations is a function of the body Strouhal number; (c) the variation of observed vibration response with flight parameters can be predicted from the base pressure fluctuation data.

2804 A TWO-LAYER VIBRATION-ABSORBING STRUCTURE.
N.I.Naumkina, B.D.Tartakovskii and M.M.Efrussi.
Akust. Zh. (USSR), Vol. 5, No. 4, 498-501 (1959). In Russian.
English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 514-17 (April-June, 1960).
The addition of a lightweight plastic foam layer between a steel bar and a vibration damping layer gave a logarithmic decrement for flexural vibration up to six times that achieved with a single damping layer of equal superficial weight. Curves are given for optimum values of layer thicknesses and weights. H.D.Parbrook

2805 VIBRATION OF, AND BENDING-WAVE PROPAGATION IN PLATES. E.J.Skudrzyk, B.R.Kautz and D.C.Greene.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 36-45 (Jan., 1961).
The theory of electrical lines and filters is based on the concept of a characteristic impedance. Similar concepts are permissible for mechanical systems. It thus becomes possible to derive a generalized theory of vibrating systems that is free from insignificant characteristics of the vibrator. The conclusions are illustrated by computations and by measurements for flat plates. The results are used to develop a theory of the propagation of bending waves in plates and shells on lines similar to the theory of reverberation in room acoustics.

2806 FREE EXTENSIONAL TORSIONAL VIBRATIONS OF A PROLATE SPHEROIDAL SHELL.
F.L.DiMaggio and A.Silbiger.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 56-8 (Jan., 1961).
The axisymmetric extensional modes of free vibrations of a thin prolate spheroidal shell separate into two classes, one class with displacements in the meridional planes. This paper concerns itself with the former, the torsional modes. The differential equation for the mode shapes, obtained by application of Hamilton's principle, is found to be satisfied by single prolate spheroidal angle functions of the first kind, and the transcendental frequency equation is readily solved with the aid of tabulated eigenvalues. Numerical and graphical nondimensional results are presented for the first eight modes.

THERMOELASTIC PROBLEM FOR A WEDGE. See Abstr. See Abstr. 1716.

2807 FINITE-AMPLITUDE FLEXURAL WAVES THAT RETAIN THEIR PROFILE DURING PROPAGATION.
M.A.Isakovich.
Akust. Zh. (USSR), Vol. 6, No. 1, 121-2 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 1, 117-19 (July-Sept., 1960).
In a continuous medium, the profile of a wave does not change during propagation if its amplitude is infinitesimal; when there is

dispersion, the profile changes, except for sinusoidal waves or for transverse waves on a string. There is one anomalous case of flexural waves on a rod, in which the profile of waves of finite amplitude does not change provided they have waveforms of certain shapes. These are illustrated. H.J.H.Starks

2808 A RAYLEIGH-TYPE FLEXURAL WAVE. Yu.K.Konenkov.
Akust. Zh. (USSR), Vol. 6, No. 1, 124-6 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 1, 122-3 (July-Sept., 1960).

The flexural vibrations of a thin semi-infinite plate are discussed and it is shown that flexural waves having the properties of a Rayleigh wave can be propagated along the edge of the plate. A table is given showing the ratio of the velocities of the flexural Rayleigh waves and of ordinary flexural waves in plates made of rubber, Pb,Al and brass. In these materials, the Rayligh wave has the lower propagation velocity, the difference being greater in plates with a higher Poisson's ratio. The differences are 1 % or less. H.J.H.Starks

2809 EXTENSIONAL WAVES IN A SEMI-INFINITE ELASTIC ROD. H.D.McNiven.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 23-7 (Jan., 1961).

In conducting experiments on waves in an elastic rod, Oliver (Abstr. 4050 of 1957) discovered a new mode of symmetric vibration in which the motion was predominantly at the end of the rod. It is shown that this "end mode" arises when pure extensional waves are coupled with waves with complex wave numbers. Approximate equations are used to study the reflection of pure extensional waves at the end of a semi-infinite rod. The properties of the resulting end mode are studied in detail and are compared with the phenomena reported by Oliver.

2810 THE CAUCHY PROBLEM FOR ELASTIC WAVES IN AN ANISOTROPIC MEDIUM. G.F.D.Duff.
Phil. Trans A (GB), Vol. 252, 249-73 (Feb. 18, 1960).

The propagation of elastic waves in a homogeneous solid is governed by a hyperbolic system of three linear second-order partial differential equations with constant coefficients. When the solid is also isotropic, the form of these equations provides the foundation of the conventional theory of elasticity (Love 1944). The explicit solution of the initial value, or Cauchy, problem for the isotropic case was found by Poisson, and in a different way by Stokes (1883). If the initial disturbance is sharp and concentrated, the resulting disturbance at a field point will consist of an initial sharp pressure wave, a continuous wave for a certain period, and a final sharp shear wave. The disturbance then ceases. Here a medium is considered which is homogeneous but not isotropic, and, using Fourier transforms, the elastic waves produced by a local initial disturbance are described The solution again consists of a continuous wave which lasts for a definite period of time, and a number of sharp waves, but the detailed nature of the waves may, in highly anisotropic media, be very different and much more complicated. The continuous wave may arrive at a field point in advance of the first sharp wave, though it will always terminate with the last sharp wave. The number of the sharp waves may not exceed 75. The solution appears as the sum of three modes, which correspond to the three sheets of a certain wave surface. The geometry of this surface, which may be quite complicated (Abstr. 800 of 1955) qualitatively determines the nature of the solution. These calculations may serve as a foundation for the study of time-dependent elastic waves. There is also mathematical interest in this example of a hyperbolic system for which the wave surface may have certain types of singularity not usually considered in the existing general theory of hyperbolic differential equations.

2811 DIFFRACTION OF AN ELASTIC PULSE IN A LOADED HALF-SPACE. R.W.Fredricks.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 17-22 (Jan., 1961).

The problem of the diffraction of a plane compression pulse by a rigid, incompressible semi-infinite body in lubricated contact with a homogeneous, isotropic, perfectly elastic half-space is formulated by a potential function and separation of variables approach. The boundary conditions are expressed by dual integral equations that are solved by a function-theoretic technique. The exact solution is obtained, as a function of space and time variables, in a closed form.

2812 RANDOM RESPONSE OF TWO COUPLED RESONATORS WITHOUT LOADING.
C.T.Morrow, B.A.Troesch and H.R.Spence.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 46-55 (Jan., 1961).

The root mean square response of a simple mechanical resonator mounted on another, which is excited by vibration of a flat motional power spectrum, is investigated theoretically for the case of no loading effect between resonators. While the solutions are not general for any pair of coupled resonators, the condition of zero loading is of particular interest, as it leads to extreme vulnerability of electronic and electromechanical equipment to shock and vibration when there is a coincidence of resonance frequencies of coupled resonators. Approximate formulae are obtained and computed by hand. The exact equation is solved on a digital computer to yield a series of curves for comparison. The approximate formulae hold surprisingly well, except when the resonators are close in frequency and highly damped. Curves of the derivative of the r.m.s. response, as one resonance frequency or the other is varied, are obtained by use of the digital computer. They illustrate the importance of mechanical tolerances in relation to detuning as a factor in design changes for improved reliability.

2813 CAPACITIVE ACCELEROMETERS WITH OPTIMUM FREQUENCY-RESPONSE CHARACTERISTICS.
E.Rule, F.J.Suellentrop and T.A.Perls.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 33-5 (Jan., 1961).

A series of capacitive accelerometers with frequency-response characteristics governed by the resistive and elastic properties of a thin air film are described. The accelerometers have been designed, in accordance with theory developed previously, to have response constant within ±5% at frequencies up to 1.48 times the undamped natural frequency. Experimental data are given to show that the accelerometer response agrees closely with that predicted theoretically.

ACOUSTICS

2814 EQUIVALENT ELECTRICAL CIRCUITS FOR NON-QUASISTATIONARY-VIBRATING, MATERIALLY-ACTIVE ELECTROMECHANICAL TRANSDUCERS (PIEZO-ELECTRIC, ELECTROSTRICTIVE, MAGNETOSTRICTIVE).
F.A.Fischer.
Acustica (Internat.), Vol. 9, 215-20 (1959) [=Akust. Beihefte, No. 1 (1959)]. In German.

2815 EXPERIMENTAL INVESTIGATION OF CYLINDRICAL FOCUSSING SYSTEMS. I.N.Kanevskii.
Akust. Zh. (USSR), Vol. 6, No. 1, 123-4 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 1, 119-21 (July-Sept., 1960).

Sharp differences between theoretical and experimental results were found for the field distribution from cylindrical $BaTiO_3$ radiators when measured (in the range 600-900 kc/s) by a precision microhydrophone (0.02 mm dia.). Amplification factors were reduced by over 30% and secondary maxima very much increased. The discrepancies were caused by standing waves in the surface of the radiator. Exciting the transducer at a frequency which reduced this parasitic radiation gave a field distribution closely approaching theoretical. At resonance a half-wave filter of Duralumin eliminated these effects and gave an amplification factor 23% above theoretical with secondary maxima correspondingly reduced. V.J.Hammond

2816 REMARKS ON THE EFFECTIVE DYNAMIC PARAMETERS OF INHOMOGENEOUS MEDIA DURING PROPAGATION OF SOUND WAVES. A.Ratinskaya.
Akust. Zh. (USSR), Vol. 6, No. 1, 128-31 (1960). In Russian. English translation in: Soviet Physics - Acoustics (USA), Vol. 6, No. 1, 127-9 (July-Sept., 1960).

Attention is drawn to errors made in two recent papers by Khaikovich and Khalfin (Abstr. 987-8 of 1960) on density and velocity of sound in inhomogeneous media. H.J.H.Starks

2817 INVESTIGATION OF SURFACE WAVES IN AIR. K.M.Ivanov-Shits and F.V.Rozhin.
Akust. Zh. (USSR), Vol. 5, No. 4, 495-6 (1959). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 510-12 (April-June, 1960).

An apparatus was designed to observe travelling surface waves

in air. A battery of loudspeakers transmitted sound over an aluminium grill onto a rigid reflector. Theory suggests that surface waves originating beneath the grill should show a pressure variation obeying $P_0e^{-\alpha z - ihx}$, where α is the attenuation factor and h the wave number of the surface. Measurements were made between 200 and 500 c/s because at lower frequencies the waves have small attenuation and velocity dispersion and at higher frequencies they become concentrated into a thin layer. A rapid-response level recorder connected mechanically with a microphone enables the acoustic pressure to be measured along the three perpendicular directions. From such records the velocity and attenuation of the waves were determined and compared with calculated quantities.

J.D.Rands

2818 TRAPPING OF ACOUSTIC ENERGY NEAR A SOURCE ABOVE A SUBMERGED ELASTIC PLATE.

M.A.Biot and J.H.Rosenbaum.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 27-32 (Jan., 1961).

The propagation of acoustic waves in a layered medium is considered for the case of an elastic plate submerged at a certain depth below the surface of a liquid-filled half-space. It is shown that there exist unattenuated modes for the plate—liquid layer system which have horizontal phase velocities greater than the sound velocity in the liquid. In spite of such greater phase velocities, radiation into the liquid below does not take place because the lower surface of the plate exhibits no vertical motion. Thus, energy can be trapped in and above the plate by vibrations which leave the underlying liquid undisturbed. It is pointed out that radiation in the horizontal direction may also be very small when the above conditions of total reflection are approximately satisfied, as is indicated by the existence of low group velocities for the modes of a free plate. Attention is called to the three-dimensional nature of such trapping, vertically by an approximate condition of no transmission across the plate, and horizontally by the simultaneous vanishing of the group velocity at nonvanishing angles of incidence. The present modes are in contrast with the usual case of total reflection and "wave guide propagation" in layered elastic media, where the horizontal phase velocity is less than the sound velocity in the liquid (lower half-space), and the signal below the plate decays exponentially with distance from the interface. Conditions under which the present modes can arise have been found and evaluated numerically. Relations between phase velocity, wave number, and ratio of fluid layer to plate thickness are presented for a lucite plate in water. These have been compared with the results of much more elaborate calculations for the point source "singing" problem.

2819 PULSE SUPERPOSITION METHOD FOR MEASURING ULTRASONIC WAVE VELOCITIES IN SOLIDS.

H.J.McSkimin.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 12-16 (Jan., 1961).

The frequently used pulse method involves a high-frequency quartz crystal transducer cemented to one end of a specimen having parallel end faces. The phase shift for waves reflected from the transducer must be considered for highest accuracy. It is shown that combining several measurements of phase delay (at two frequencies differing by approximately 10%) with a theoretical analysis of the reflection phase angle makes possible a determination of velocity to within one part in 5000 for round-trip delays greater than 5 μsec. Indirectly, the approximate thickness of the cement bond between transducer and specimen can be determined. The advantages of the method for making measurements as a function of temperature or pressure are discussed.

2820 COMPARISON OF DIRECTLY MEASURED SOUND VELOCITIES WITH VALUES CALCULATED FROM HYDROGRAPHIC DATA. E.E.Hays.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 85-8 (Jan., 1961).

Hydrographic data (temperature, salinity, depth) and directly-measured sound velocities were obtained from a section made at 6°E across the Mediterranean Sea in June and July, 1959. Sound velocities were calculated from the hydrographic data and compared with the measured values. Two methods were used to calculate the sound velocity from the hydrographic data. One method used Del Grosso's zero depth values with the depth correction from Matthew's Tables. The other method used the empirical equation of Wilson (Abstr. 10708 of 1959; 10721 of 1960) derived from laboratory measurements made at the Naval Ordnance Laboratory. The significant difference observed in the comparisons appears below 200 m. Here the corrections using Matthew's Tables result in too large values for the velocities at depth, the magnitude of the difference being about 2.5 m/sec at 2500 m depth. The calculated values from Wilson's equation agree with the experimental values more closely (about 0.5 m/sec difference at 2200 m depth).

2821 ON THE DEFINITION OF AN ATTENUATION COEFFICIENT FOR A NON-PERIODIC PULSE OF SOUND. C.Sălceanu and M.Zăgănescu.
C.R. Acad. Sci. (France), Vol. 251, No. 16, 1615-17 (Oct. 17, 1960). In French.

Theoretical expressions for the coefficient are derived.

H.D.Parbrook

2822 ULTRASONIC ATTENUATION OF LONGITUDINAL WAVES IN PLASTICS. M.Auberger and J.S.Rinehart.
J. appl. Phys. (USA), Vol. 32, No. 2, 219-22 (Feb., 1961).

Hughes' pulse technique for measuring longitudinal velocities (Abstr. 4574 of 1949) has been adapted and extended to measure attenuation of longitudinal waves in the frequency range from 250 to 1000 kc/s. Data for attenuation in nepers per wavelength in six different plastics (Plexiglas, polystyrene, nylon 101, Formica XXN, polyethylene, and Teflon) are given for eight different frequencies ranging from 250 to 1000 kc/s. The results for Plexiglas and polystyrene are compared with results obtained previously by other methods. Attenuation in nepers per wavelength has been found to decrease when frequency increases for all plastics, except for Teflon, which shows a well-defined peak at about 700 kc/s.

2823 ABSORPTION OF ULTRASONIC WAVES IN ETHYL ACETATE.

S.Barledzh [S.R.Buralge] and E.Kérom [E.F.Carome].
Akust. Zh. (USSR), Vol. 5, No. 4, 490-2 (1959). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 504-6 (April-June, 1960).

A sensitive interferometric measurement was made of the ultrasonic absorption to investigate the reported additional maximum occuring at frequencies below 10 Mc/s. Fluctuations in the value of the absorption were observed which were shown by analysis of the measuring system to agree with the anticipated result of diffraction arising from the disk shaped transducers. The authors concluded that their observed increase in α/f^2 at the lower frequencies, as well as the second relaxation frequency, were caused by virtual damping due to diffraction effects.

J.D.Rands

2824 EFFECT OF THE ELASTICITY OF THE MEDIUM ON THE RADIATION IMPEDANCE OF A PISTON SET IN A BAFFLE. D.N.Chetaev.
Akust. Zh. (USSR), Vol. 5, No. 4, 501-3 (1959). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 518-20 (April-June, 1960).

The medium is assumed to have a shear modulus. Theoretical expressions are presented for the dimensionless resistive and reactive components of the radiation impedance. The calculated values for an elastic Poisson medium and for an ideal fluid are compared.

H.D.Parbrook

2825 NEW POSSIBILITIES IN THE PULSE TECHNIQUE OF TWO FIXED DISTANCES.

V.N.Zalivchii, N.I.Koshkin and V.F.Nozdrev.
Akust. Zh. (USSR), Vol. 5, No. 4, 493-5 (1959). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 508-10 (April-June, 1960).

Two systems of pulses were photographed after reflection from steel plates placed at unequal distances on either side of a quartz plate generator. An additional "satellite" pulse was also observed being formed by the two pulses transmitted in opposite directions and travelling the total acoustic path between the reflectors. The satellite intensity was $I_C = 4\kappa\kappa_1^2 I_0 e^{-4\alpha(x_1 + x_2)}$, where x_1 and x_2 were the respective distances from the generator to the reflectors with reflection coefficient κ_1; κ was the transmission coefficient of the quartz plate. From equations for the intensities of the two systems of pulses the coefficients κ and κ_1 could be evaluated.

J.D.Rands

2826 THE SHADOW ZONE IN THE PROPAGATION OF SOUND IN THE SEA. G.Pazienza.
Elettrotecnica (Italy), Vol. 46, No. 9, 642-7 (Sept. 15, 1959). In Italian.

Sound waves are refracted by the presence of thermal gradients in the sea. Empirical equations for the velocity of sound are used as the basic for a theory which enables the formation of shadow zones to be predicted. The form of these zones is indicated for the two most common types of temperature distribution.

V.G.Welsby

2827 PROCEDURE FOR INVESTIGATING SOUND SCATTERING IN THE ATMOSPHERE. M.A.Kallistratova.
Akust. Zh. (USSR), Vol. 5, No. 4, 496-8 (1959). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 512-14 (April-June, 1960).

An 11 kc/s pulse technique made it possible to isolate the required scattered signal from the direct and reflected ones. The construction, operation and performance of plane electrostatic transducers with good transfer characteristics—both as radiators and as microphones—are discussed. J.D.Rands

Instruments and Measurements

2828 AUTOMATIC PROCESSING SYSTEM FOR ACOUSTICAL DATA. W.E.Parker and L.V.East.
J.Acoust. Soc. Amer., Vol. 33, No. 1, 1-6 (Jan., 1961).

An improved instrumentation system has been developed to analyse the dynamic pressure field produced by jet aircraft. The system is automatic and utilizes analogue computer techniques to obtain an accuracy of ±0.2 dB in its readout. The method used is to secure a true r.m.s. value of octave band segments of the jet noise spectrum and to convert this to decibels by the use of a d.c. logarithmic amplifier. The transition to acoustical decibels is made by obtaining the difference between this voltage and another voltage obtained from a reference oscillator. The value of this reference oscillator in acoustical decibels is obtained by comparing its output voltage to that of a calibrated microphone. The dynamic range of the system has proved more than adequate for greater than 98% of the data processed by this unit during the time this system has been in operation. The output is in the form of punched cards for utilization with a digital computer.

2829 SONAR TRANSDUCER PULSE CALIBRATION SYSTEM. J.D.Wallace and E.W.McMorrow.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 75-84 (Jan., 1961).

The development of equipments and techniques for making measurements on underwater transducers is described. The Naval Air Development Centre used a circular tank with no special linings, and directed its effort to develop a suitable electronic pulse test equipment. It is concluded that the accuracy and reliability of the calibration facilities, measurement techniques, and the use of the round wooden tank are satisfactory for most underwater transducer evaluations.

2830 POSSIBILITIES AND LIMITATIONS OF THE USE OF LOW FREQUENCIES FOR ECHO-LOCATION.
G.Pazienza.
Alta Frequenza (Italy), Vol. 29, No. 3-4, 323-36 (July-Aug., 1960). In Italian.

The various factors which limit the range of underwater acoustic echo-location systems are explained and the question of choice of optimum carrier-frequency is discussed. The frequency range 2 to 30 kc/s is considered and it is concluded that some small advantage may be gained by the use of frequencies at the lower end of this range. V.G.Welsby

2831 LOW FREQUENCY UNDERWATER SOUND VELOCITY METER. J.D.Shaffer.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1318-20 (Dec., 1960).

The meter employs an open-end heavy-walled tube for a resonant cavity. The water column is excited into vibration by a sound source near one end, while a hydrophone probe at the tube centre registers the pressure amplitude. A sharp resonator ($Q \cong 450$) permits making relative measurements with an uncertainty of less than 0.2 m/sec when the fundamental mode ($f \cong 570$ c/s) is used.

Noise . Architectural Acoustics

2832 SOME PERIODIC VARIATIONS IN LOW-FREQUENCY ACOUSTIC AMBIENT NOISE LEVELS IN THE OCEAN.
G.M.Wenz.
J. Acoust. Soc. Amer., Vol. 33, No. 1, 64-74 (Jan., 1961).

Variations in underwater acoustic ambient noise spectra, from 20 to 1250 c/s, were analysed using a statistical filter technique to examine the spectral density functions in the range from 1 to 80 cycles per week. At frequencies below 100 c/s narrow band components at seven cycles per week were observed in the spectral density functions. In several cases harmonics of the seven-cycle-per-week component were also evident. The period of the cyclic variation agreed more closely with the solar day than with tidal period. The maxima occurred at approximately midnight local zone standard time, and at one location additional maxima were observed at approximately noon. The magnitudes of the periodic variation were small, 1.5 to 5.0 dB, showing little evidence of seasonal dependence, except that at one location daily changes of 10 to 20 dB were observed during the period of the summer solstice while hardly any periodic change was evident during the winter solstitial season. These periodic changes in the ambient noise levels were not correlated with changes in local wind speed.

2833 THE TRANSMISSION OF ROOM INFORMATION. K.Wendt.
Rundfunktech. Mitt. (Germany), Vol. 4, No. 5, 209-12 (Oct., 1960). In German.

The acoustical properties of a closed room influence the development in time and space of the sound pressure that is caused by the occurence of a sound in the room. The time function originated by the sound source thus acquires, on its way to the listener, additional information concerning the room in which the sound takes place, and this the author calls the room information. With electro-acoustical transmission, the room information may be made audible in the listening room by wau of its own channel. Measurements of the optimum loudness of the room information transmitted indicate that it is a function of the size and reverberation-time of the originating room.

2834 APPARATUS FOR MEASURING THE ACOUSTIC MERIT OF ROOMS. H.Niese.
Nachrichtentechnik (Germany), Vol. 10, No. 11, 487-94 (Nov., 1960). In German.

The usual methods of room assessment are reviewed and the conclusion is reached that a 5 to 10 msec burst of 1 kc/s tone gives the best approximation to the excitation characteristics of speech. The source is a pressure loudspeaker with a short horn in an artificial head, the 1 kc/s tone being triggered electronically. The measuring apparatus consists of two stereophonic microphones, the r.m.s. sum of the channels being applied to a dB meter. The received sound is integrated over the first 35 msec, it being held that this gives a useful measure of the reproduction of speech at the particular position in the room which is under test. Some results are given. M.L.Gayford

OPTICS . PHOTOMETRY

2835 OPTICS, PHYSICS AND OPTICAL PHYSICS. V.Ronchi.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 22-31. In Italian.

A general review of the terminology used in optics. In particular it is suggested that the term "optics" be limited to cases where the eye is the receiver. Obvious extensions to other receivers, give one "photography" and "photoelectrics". In cases where electromagnetic radiation of any wavelength is considered without a particular receiver, the term "physics" is appropriate. R.W.Fish

2836 A HIGH-PRECISION PHOTOELECTRIC PHOTOMETER. O.C.Jones and C.L.Sanders.
J. Opt. Soc. Amer., Vol. 51, No. 1, 105-8 (Jan., 1961).

During work on the primary standard of light a photometer was developed which possesses desirable qualities. The detector used is a Gillod—Boutry vacuum photocell with caesium—bismuth cathode surface having a basic sensitivity of 25 μA/lu. The photocurrent is measured by a simple circuit, using balanced electrometer tubes, similar to circuits which have been described frequently over a long period of time in the literature, except in one rather important respect which is described fully. The photometer is compact and portable. Battery replacement is only necessary every three months. Differences between successive readings and zeros repeat to $\pm 2/10^4$ when measuring a steady incidence of 10^{-4} lu. Zero drift is

small, necessitating readings only every 15 min. Circuit stability is good, so that the simple balance adjustment need not be used more than twice daily, provided that the triodes are suitably matched. Due to undetermined causes day-to-day variations in sensitivity of 0.5% sometimes occur.

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

2837 PROOF OF THE POSSIBILITY OF EXCEEDING THE INFORMATION LIMITS POSTULATED BY THE SAMPLING EXPANSION THEOREM. H.Wolter.
Optica Acta (Internat.), Vol. 7, No. 1, 53-64 (Jan., 1960). In German.

A method was described previously (Abstr. 2225 of 1960) for the precise calculation of object qualities from image properties though the aperture is finite. Here the fundamental possibility of such a procedure is demonstrated by a more direct proof. In this way the sampling expansion theorems setting limits to the information, even in the case of the absence of erors, may be transgressed and the methods described for an improved resolution beyond the Abbe value are shown to be allowed. The object is not supposed to have a finite and an a priori known number of degrees of freedom. According to the practical possibilities in all cases of coherent illumination, the limits for intensity and illumination are supposed to have a finite and a definite value.

2838 FOURTH ORDER FINITE DIFFERENCE EQUATION FOR THE HELMHOLTZ EQUATION FOR SYSTEMS OF REVOLUTION. A.Lévy.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2126-8 (Nov. 14, 1960). In French.

The Helmholtz equation, expressed in cylindrical coordinates, is expanded in a Taylor series for a lattice of eight neighbouring points. Terms of order higher than four are neglected. The difference equation is found by solving these equations with three more obtained by differentiating the Helmholtz equation.

H.Morrison

2839 THE DEVIATION OF LIGHT WAVES BY THE MOVEMENT OF REFRACTING MEDIA. A.Metz.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2132-4 (Nov. 14, 1960). In French.

The case is considered of refraction at a liquid–air interface when the liquid is moving. The relativity considerations are discussed. The modifications in refraction and in the total reflection for direct observation are too small, but they are noted here from the theoretical point of view since the effects are different from those of propagation in a vacuum. S.Tolansky

2840 THE PHASE FRESNEL LENS. K.Miyamoto.
J. Opt. Soc. Amer., Vol. 51, No. 1, 17-20 (Jan., 1961).

In order to deform the wave surface passing through an optical system by the amount $\phi(u,v)$ it is suggested that a phase Fresnel lens be inserted in the pupil of the optical system. Assuming $0 \leq \phi(u,v) < m\lambda$, the (u,v) region of the pupil is divided into m zones by Fresnel's condition

$$(k-1)\lambda \leq \phi(u,v) < k\lambda; \quad \text{kth zone, } k = 1, 2, \cdots, m,$$

where λ is the wavelength. If the phase Fresnel lens be made so that it shifts the wave surface by the amount $\phi(u,v) - (k-1)\lambda$ in each kth Fresnel zone, the amount of its deformation in each zone is smaller than λ, but this phase Fresnel lens is quite equivalent to a lens which deforms the wave surface by $\phi(u,v)$ because of Fresnel's condition. Some properties of the phase Fresnel lens are discussed. This technique is more applicable to the infrared region.

2841 USE OF GRIDS IN TESTING OBJECTIVES. R.Schalge.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 325-31. In German.

One grid is imaged on a second by the objective under test and the aberrations are deduced from the moiré fringe pattern formed.

W.T.Welford

2842 CONTRIBUTIONS TO THE OPTICS OF MIRROR SYSTEMS AND GRATINGS WITH OBLIQUE INCIDENCE. I. RAY TRACING FORMULAS FOR THE MERIDIONAL PLANE. G.R.Rosendahl.
J. Opt. Soc. Amer., Vol. 51, No. 1, 1-3 (Jan., 1961).

General ray tracing formulae have been developed for the "meridional plane" of noncentered optical systems consisting of imaging mirrors and gratings. It has been assumed that all centres of curvature of object and image field and of the aperture diaphragm lie in the meridional plane and that the grooves of a grating are perpendicular to that plane. The ray-tracing formulae have been simplified for a general ray with only small deviations from the instrument axis (zero ray). The influence of a change of diffraction for curved gratings has been included.

2843 ON THE DESIGN OF OPTICAL SYSTEMS WITH AN ASPHERIC SURFACE. K.Miyamoto.
J. Opt. Soc. Amer., Vol. 51, No. 1, 21-2 (Jan., 1961).

The problem of designing a correcting aspherical surface which is situated in an arbitrary position within an optical system is considered. The method requires the solution of two first-order differential equations and seems more suitable for use with an electronic computer than methods previously proposed by other authors. It can be considered as a differential form of a method previously proposed by Wolf (Abstr. 949 of 1949).

2844 FIBER OPTICS. VII. IMAGE TRANSFER FROM LAMBERTIAN EMITTERS. N.S.Kapany and D.F.Capellaro.
J. Opt. Soc. Amer., Vol. 51, No. 1, 23-31 (Jan., 1961).

For Pt VI,see Abstr. 9503 of 1959. Light leakage between fibres for the particular case of their use with Lambertian emitters is discussed. The associated problems of the degree of optical contact between the fibre ends and the emitting source, and their effects on the overall transmitting efficiency are considered in detail and results are presented for several representative emitters. A transmission theory of fibres based on meridional ray considerations alone is derived and shown to be adequate for high numerical aperture fibres. The general expressions, from which the simplified theory is deduced, are given in an appendix to the paper. Results are presented for an experimental system which has been constructed and tested. These results demonstrate that photometric gains of up to 40 or 140 are available when using a fibre optics cathode-ray tube in place of a standard tube and unit magnification f/1 and f/2.8 lens systems, respectively. The fusion processes entailed in the construction of such tubes and similar devices are considered. Fibres with a numerical aperture of 1.17 which retain their circular cross section during these processes are described.

2845 FIBER OPTICS. VIII. THE FOCON. N.S.Kapany.
J. Opt. Soc. Amer., Vol. 51, No. 1, 32-4 (Jan., 1961).

Fibre optical elements, in the form of a "field flattener", a "distortion corrector", and a "conical condenser" are combined in a single unit termed the "focon". It is capable of correcting for field curvature and distortion of a lens system and because of the increase in photographic speed using conical fibres, the problem of other aberrations is minimized. Various features of a focon are discussed and it is shown that high performance optical systems are possible using simpler lens systems in conjunction with a focon.

2846 ELECTRO-OPTICAL SYSTEMS USING FIBRE OPTICS. N.S.Kapany.
Optica Acta (Internat.), Vol. 7, No. 3, 201-17 (July, 1960).

Fibre optics holds considerable promise for applications in various types of electro-optical systems. Conventional means of recording or relaying information presented upon a Lambertian emitter such as the phosphor in a cathode-ray tube or photocathode in a multistage image intensifier, etc., suffer from considerable light losses and low resolution. An appropriate assembly of glass fibres is capable of transporting the image with elimination of halo

and yields high resolution and photometric gain. Similarly fibre optics offers considerable advantages in scanning photometry, colour television and character-reading systems. For applications in electron optical systems, such as a coupling unit for multistage image intensifiers, it is desired that the fibre optics element be composed of perfectly insulated fibres and also be sealed. To this end a method has been developed for drawing glass-coated glass fibres with a high refractive index glass core and a thin low refractive index glass coating, of the order of 1λ or less thickness. These fibres can be further coated with an absorbing coating for perfect insulation and fused so that first, the low refractive index coating and then the absorbing coating surround the high refractive index cores. Fibres drawn by this method have yielded of the order of 50% light transmission over 7 feet length. The influence of various factors such as the polar emission of different phosphors and thickness of low index coatings on the resolution and photometric efficiency of fibre optics are discussed. The influence of diffraction on the light conductivity of fibres of diameter comparable to the wavelength of light is being investigated using microwave analogues. The influence of diffraction on polar emission curves and frequency cut-off dielectric cylinders is illustrated. A method for drawing insulated "multiple fibres" consisting of individual fibres down to few wavelengths diameter is described.

2847 OPTICAL SYSTEMS WITH HIGH RESOLVING POWER. A.I.Kartashev.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 394-8 (Sept., 1960). In Russian.

Describes two new imaging systems: one of dispersion type (similar to television systems) and one of interference type. An object is placed between two spectrographs or two interference wedges, and the resultant resolving power is much (10-20 times) higher than that obtainable with the usual optical systems. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 204-6 (Sept., 1960)]. A.Tybulewicz

2848 APODIZATION. D.Yu.Gal'pern.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 549-50 (Oct., 1960). In Russian.

A design calculation is given for an amplitude-phase filter in the form of a glass plate with a given surface shape and an appropriate transmission at various points (such a plate is placed in the plane conjugate to the aperture diaphragm). [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 291 (Oct., 1960)]. A.Tybulewicz

2849 EYE LOCATION FOR A WIDE-FIELD LARGE-EXIT-PUPIL OPTICAL SYSTEM. I.J.Spiro.
J. Opt. Soc. Amer., Vol. 51, No. 1, 103-4 (Jan., 1961).

An experiment was performed to determine whether there was a preferred location for the observer's eye. The special equipment constructed for the experiment is described. A chart is provided which summarizes the results of the study in graphic form. This depicts the eye rotation angles achieved before vignetting occurs for various locations of the eye with respect to the instrument pupil.

COMBINED SCHMIDT TELESCOPES. See Abstr. 2587

2850 FURTHER DEVELOPMENT OF THE OPTICAL MICROSCOPE. E.Lau and J.Rienitz.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 229-46. In German.

A survey is given of recent developments. Higher magnifications than formerly expected can be used by having a rotating matt diffusing screen at the first focal plane and then using microscope enlargement on this. Modern interference microscopes are described. A number of coloured two-beam interferograms are illustrated. S.Tolansky

2851 THE OPTICAL COUPLING OF A SCINTILLATION CHAMBER TO AN IMAGE-INTENSIFYING TUBE. R.J.Potter and R.E.Hopkins.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 150-8 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Several methods for coupling a fibre scintillation chamber to an image intensifying tube are considered. A high-speed lens was designed to image the ends of a curved fibre bundle on the curved cathode of an image intensifying tube. The lens covers a five-inch field at one-to-one magnification, and at a speed of f/1.5. The details of this lens design and its expected performance are discussed. The results of a series of experiments on plastic scintillation fibres were used to determine that the internal reflectivity in 0.993 and absorption constant is 0.015 cm^{-1} in the fibre. The data were then used to compute the optical properties of fibres appropriate to a scintillation chamber system. Certain other optical properties of the components were estimated so that three possible optical coupling schemes could be compared in detail. They are: (1) the lens alone; (2) a glass fibre bundle alone; and (3) a combination of the lens and a glass fibre bundle. The lens alone is about half as efficient as either of the other two methods. The numerical aperture and probable transmission properties of each system are outlined.

IMAGE INTENSIFIERS WITH TRANSMITTED SECONDARY ELECTRON MULTIPLICATION. See Abstr. 3000

TRANSMISSION SECONDARY EMISSION IMAGE INTENSIFIER. See Abstr. 3001

2852 PROPOSED FIBER CAVITIES FOR OPTICAL MASERS. E.Snitzer.
J. appl. Phys. (USA), Vol. 32, No. 1, 36-9 (Jan., 1961).

The use of dielectric waveguides in the form of small fibres as the mode selector in optical masers is considered. The fibres consist of a core of index of refraction n_1 which contains the maser material, surrounded by a cladding of lower index n_2. A comparison is made with the Fabry–Perot interferometer used as a cavity. The principal advantages of the fibres for maser applications are the mode selection and the stronger mode coupling. It is shown that for core diameters just small enough to support only the two HE_{11} modes, the fraction of spontaneous emissions into the waveguide modes is given approximately by 1.4 $(n_1 - n_2)/(n_1 + n_2)$. This could make maser action possible at much lower power levels. The major disadvantage is the difficulty of pumping into the small volume of the fibre. Schemes to overcome this difficulty are discussed.

2853 THEORY OF LASER OSCILLATIONS IN FABRY–PEROT RESONATORS. J.Kotik and M.C.Newstein.
J. appl. Phys. (USA), Vol. 32, No. 2, 178-86 (Feb., 1961).

The Fabry–Perot interferometer has been suggested for use as a high-model laser (light amplification by stimulated emission of radiation) resonator. The oscillation condition for a Fabry–Perot laser is derived from an integral equation for the angular spectrum of the field. The kernel of the integral equation involves the scattering matrices of the end mirrors. This integral equation leads to a stationary expression. The use of physically reasonable trial spectra allows one to estimate the effect of "walkoff", diffraction, reflector curvature, and reflector tilt in terms of an "effective" reflection coefficient for the infinite-aperture Fabry–Perot. Taking into account the effect of "walkoff", an approximate necessary and sufficient condition for oscillation normal to the reflectors is derived.

2854 SOME DEVELOPMENTS AND APPLICATIONS OF THE OPTICAL LEVER. R.V.Jones.
J. sci. Instrum. (GB), Vol. 38, No. 2, 37-45 (Feb., 1961).

The history of the optical level is briefly reviewed from its invention by Poggendorf in 1826 to the recognition by Ising in 1926 of Brownian fluctuations of a galvanometer in the records obtained by Moll and Burger in 1925 with their thermoelectric relay. The design of optical levers and amplifiers by the author and his collaborators is outlined; these give sensitivities of the order 10^{-10} radian for a mirror 2.0 mm × 2.0 mm, and an observation bandwidth of 10 c/s. The effects of convection currents and photon fluctuations are indicated. The applications of optical levers to a range of measurements, including Brownian fluctuations, radiation pressure, linear expansion and infra-red detection are described. Optical and photoelectric systems similar to those developed for the optical lever can be used for alignment measurement; applications include refractometry for refractive index changes of order 10^{-9}, and a test of the constancy of the velocity of light in a transverse magnetic field.

2855 A FAR-INFRARED BIBLIOGRAPHY. E.D.Palik.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1329-36 (Dec., 1960).
A collection of over 500 papers dealing primarily with the region between 25 and 1000 μ. It is arranged in chronological order from 1892 to 1960.

2856 NEW TRENDS IN INFRARED SPECTROSCOPY. G.Sezerlénd [G.B.B.M.Sutherland].
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 2, 269-93 (Oct., 1959).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2(69), No. 5, 759-64 (Sept.-Oct., 1959).
The more important developments in infrared spectroscopy since 1950 are reviewed. These are (a) new instrumentation and techniques, (b) study of molecular interactions, and (c) study of high polymers. G.I.W.Llewelyn

2857 A CENTURY OF SPECTRUM ANALYSIS. É.V.Shpol'skii.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 4, 657-78 (Dec., 1959).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 6, 958-73 (June, 1960).
The story of the evolution of spectroscopy from Newton to Niels Bohr is presented. G.I.W.Llewelyn

2858 ABSORPTION SPECTROSCOPY OF DISPERSED MATERIALS. G.V.Rozenberg.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 1, 57-104 (Sept., 1959).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2(69), No. 5, 666-98 (Sept.-Oct., 1959).
The theoretical principles for the application of absorption spectroscopy to dispersed materials are discussed. The optical properties of the isolated particle, coherent cooperative effects, and multiple scattering are all considered in detail.
G.I.W.Llewelyn

2859 METHODS OF MEASURING LINE INTENSITY IN RAMAN SPECTRA. P.A.Bazhulin and M.M.Sushchinskii.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 1, 135-46 (May, 1959).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 3, 436-43 (May-June, 1959).
Discussion about the meaning of the measured intensity leads to the importance of the line shape. A method of fitting the observed shape to a two parameter equation (Voigt function) is given. After correcting for the shape of the exciting line, the true maximum and integrated intensities, and the half-width can readily be determined. The effect of background intensity, a way of correcting for it and the different effects introduced by the apparatus are also discussed. The merits of an intensity standard based on the 802 cm^{-1} line of cyclohexane are compared with those of the 495 cm^{-1} line of carbon tetrachloride. G.H.C.Freeman

2860 EXPERIMENTAL INVESTIGATIONS OF THE PERFORMANCE OF PRISM MONOCHROMATORS. K.Lenz.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 101-3. In German.
A detailed comparison is made of a single and double monochromator, as regards resolving power, spectral transmission, stray light, etc. The results indicate a better performance, in general, from the single monochromator. R.W.Fish

2861 STRAY LIGHT MEASUREMENTS IN PRISM MONOCHROMATORS. F.Fröhlich and M.Schmuntzsch.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 104-9. In German.
The stray light is shown to consist of a background light independent of wavelength and a component dependent upon the wavelength of the light being used. Methods of calculating these two components are suggested and results compared with actual measurements. R.W.Fish

2862 A VACUUM GRATING SPECTROMETER FOR THE FAR INFRARED. H.Reimann.
"Optics of all wavelengths" Meeting, Jena, 1958. (see Abstr. 224 of 1961) p. 110-14. In German.
Uses a plane grating 30 cm^2, with rulings of 1, 2 or 4 mm, a bolometer, tuned amplifier and pen recorder. Recordings show the overall response of the system for λ = 100-700 μ, for various mercury and xenon sources; in all cases the response is a maximum near λ = 150 μ. G.F.Lothian

2863 SOME PROBLEMS IN THE CONSTRUCTION OF A VACUUM SPECTROGRAPH. M.Riemann.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 115-22. In German.
An Ebert—Fastie grating instrument for the vacuum u.v. is briefly described. The decrease in reflection of an Al mirror after evaporation was investigated for λ = 1150 A. The reflection was found to fall from 60% to 20% in the 60 min following its evaporation; this is correlated with the growth of an oxide film, investigated by both electrical conductivity and interferometric measurements. The efficiency of a sodium salicylate fluorescent detector is found to be constant for the range 2500-3200 A, and to pass through a maximum with increasing film thickness. G.F.Lothian

2864 THE NEW PLANE-GRATING SPECTROGRAPH OF VEB CARL ZEISS, JENA. P.Kröplin.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 123-31. In German.
Details of design and performance are given for a new stigmatic 2 m plane grating suitable for spectrochemical analysis. A resolving power of 45000 is available in the first order. S.Tolansky

2865 ENERGY-RECORDING SPECTROFLUORIMETER. W.Slavin, R.W.Mooney and D.T.Palumbo.
J. Opt. Soc. Amer., Vol. 51, No. 1, 93-7 (Jan., 1961).
The design and application of an instrument for the measurement of excitation, fluorescence, and reflectance spectra of luminescent powders is described. Both excitation and fluorescence spectra are recorded on an absolute energy scale that is independent of wavelength. This is accomplished by internal standardization against the output of a thermocouple detector. The excitation and emission monochromators scan the wavelength region 200-700 mμ; the spectra are displayed as continuous curves on a strip-chart recorder. The use of the thermocouple detector as a reference for the calibration of both excitation and fluorescence spectra is described. Photometric accuracy better than 5% has been achieved. Typical spectra obtained for a luminescent silicate and sulphide are shown. An application involving an electroluminescent sample is shown. The instrument is also useful as a reflectometer, since reflectance may be measured without interference from fluorescence. Improvements are discussed that would permit the instrument to record in terms of quantum yield rather than energy. In addition, the instrument may be extended farther into the red by different detectors.

2866 A "SPECTROVISOR". M.M.Gurevich and K.I.Kolyadin.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 253-6 (Aug., 1960).
In Russian.
Describes a fast spectrophotometer which traces simultaneously the transmission spectra of a test and a standard sample on the screen of a cathode-ray tube. The instrument, (called a "spectrovisor") is suitable for the visible region and its speed can be judged from the fact that each transmission curve is traced in 0.01 sec. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 131-3 Aug., 1960)]. A.Tybulewicz

2867 SLIT-WIDTH ERROR IN THE MEASUREMENT OF ABSORPTION CONSTANTS.
A.Lempicki, H.Samelson and A.Brown.
J. Opt. Soc. Amer., Vol. 51, No. 1, 35-40 (Jan., 1961).
Interest in the optical properties of semiconductors and insulators inside the region of the fundamental absorption edge required the development of instrumentation and material suitable for these investigations. The chief characteristic of these measurements is a very large absorption constant that varies rapidly with wavelength. Because of this, and the requirement that a finite slit be used, such measurements can be subject to large errors. These arise because of transmission in the tails of the slit distribution while, at the wavelength under observation, the sample is relatively opaque. The current work investigates the nature of the distribution of energy emergent from the slit of an optical monochromator and finds that this is close to being Gaussian. The information is used to find the true transmission by the method of Hardy and Young (Abstr. 6075 of 1949) and two specific examples are given as an illustration.

2868 DISTORTION OF SPECTRAL LINE SHAPES BY RECORDING INSTRUMENTS. K.Frei and H.H.Günthard.
J. Opt. Soc. Amer., Vol. 51, No. 1, 83-6 (Jan., 1961).

Input signals defined as intensities were assumed to have Gaussian- or Lorentz-shape functions. A rectangular optical slit function was chosen, neglecting any diffraction effects. The effect of recording was described using constant scanning and recording speed and a simple low-pass RC filter as noise damping network. Formulae for the distorted output signals have been derived and evaluated numerically by means of an electronic digital computer. Curves and tables are given representing signal distortion, characterized by frequency shift, decrease of peak height and increase of band half-width. It may be seen that the distortion effect will be negligible if both $\rho \leq 0.1$ and $\kappa \geq 10$. The integral over the distorted signal equals the original integral and will not be affected by optical slit and recording under the conditions assumed here.

2869 MULTIPLE-TRAVERSE ABSORPTION CELL DESIGN. T.H.Edwards.
J. Opt. Soc. Amer., Vol. 51, No. 1, 98-102 (Jan., 1961).

An approximate expression is derived for the length of a stigmatic final image in multiple-traverse cells of the White type (Abstr. 2320 of 1942). The length of the final tangential image is, for a point source,

$$\Delta L_T \cong \frac{hb^2}{12R^2}\left(N - \frac{4}{N}\right)$$

where h is the height of the "rear" mirrors illuminated, b is the separation of the entrance and exit images, R is the common radius of curvature of the three spherical mirrors, and N is the number of traversals. Direct experimental measurements of image length for two sets of mirrors are in agreement with the calculated values. The results are discussed in terms of design parameters, and two new cells constructed in accordance with these principles are discussed.

2870 PROPERTIES OF FOCAL SURFACES OF MIRROR SPECTROGRAPHS. S.A.Khrshanovskii.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 399-406 (Sept., 1960). In Russian.

Investigates theoretical focal surfaces of spectrographs with spherical camera mirrors. Focal curves, representing intersections of focal surfaces by meridional planes, are studied as a function of the position of a dispersing element. Simple relationships are obtained which describe behaviour of these curves in their central (working) parts. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 207-10 (Sept., 1960)].
A.Tybulewicz

2871 IMPROVEMENTS IN A SOURCE FOR USE IN THE VACUUM ULTRAVIOLET. P.L.Hartman.
J. Opt. Soc. Amer., Vol. 51, No. 1, 113-14 (Jan., 1961).

An improved version of a low-pressure hot cathode discharge lamp for use in the vacuum ultraviolet is described. It has been used with hydrogen, helium, argon, and nitrogen to furnish line radiation from below 500 to about 1650 A and continuum radiation from hydrogen from 1650 to 3500 A. The lamp operates at low voltages, is reliable, and simple to rejuvenate when the output becomes low. Figures are given on its output as seen through a specific monochromator.

2872 ARC SOURCE FOR HIGH TEMPERATURE GAS STUDIES. J.B.Shumaker, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 65-7 (Jan., 1961).

A wall-stabilized water-cooled copper ring arc source is described which operates stably in apparently any gas for periods of an hour or more at currents up to 100 A. Arc temperatures obtained spectroscopically by absolute line intensity and line profile methods are given for the arc in nitrogen at 92 A.

2873 RELATION BETWEEN THE FREQUENCY AND THE LUMINOUS EFFICIENCY OF THE FLUORESCENT TUBE. J.C.Risler and R.Hardy.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2326-8 (Nov. 21, 1960). In French.

The efficiency of light production is considerably increased at higher frequencies. A curve shows that in a tube (nominally of 6 W) run at constant luminosity, the power dissipated is between 10 and 11 W from 50 c/s to 5 kc/s, but decreases sharply to 6 W at 15 kc/s.
S.T.Henderson

2874 OPTIMUM CONDITIONS FOR MEASUREMENT OF ABSORPTION BAND WIDTHS. G.G.Petrash.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 423-4 (Sept., 1960). In Russian.

Discusses simultaneous measurement of the optical density and the bandwidth in the case of small systematic errors but without assuming that the instrument is perfect. Gives recommendation for minimization of the experimental errors in simultaneous measurements of the optical density at the band maxima and the bandwidths. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 221 (Sept., 1960)].
A.Tybulewicz

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

2875 THEORY OF REDUCTION OF REFLECTION BY METAL FILMS. P.G.Kard.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 248-52 (Aug., 1960). In Russian.

Simplified Vlasov's formulae are used to develop a theory of reduction of reflection by introduction of a suitable multilayer dielectric coating between a metal film and its support (base). [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 129-31 (Aug., 1960)].
A.Tybulewicz

2876 FUNDAMENTALS OF A THEORY DEALING WITH SYNTHESIS OF ABSORBING ANTIREFLECTION COATINGS. P.G.Kard.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 386-93 (Sept., 1960). In Russian.

Discussed coatings consisting of several absorbing layers separated by transparent layers. It is shown that antireflection properties are governed primarily by absorbing layers and a simple expression representing this fact is obtained. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 200-4 (Sept., 1960)].
A.Tybulewicz

2877 FORMULAE FOR REFLECTION AND TRANSMISSION OF LIGHT BY A THIN METAL FILM. A.Vašíček.
Z. Phys. (Germany), Vol. 161, No. 1, 26-37 (1960). In German.

The author claims to have discovered an error in the generally accepted formulae. New formulae are suggested which are derived by considering multiple reflections at both surfaces.
W.T.Welford

2878 PHASE DISTRIBUTION IN YOUNG'S INTERFERENCE EXPERIMENT. G.Westheimer.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1338 (Dec., 1960).

A simple calculation is given for Young's fringes which shows that the amplitude undergoes a change of sign at each node. This is equivalent to a phase change of π at the node. Thus the lines of equal phase are in circular arcs. The phase jump at a node is equivalent to the similar jump at the Airy dark rings in Fraunhofer diffraction.
S.Tolansky

2879 AMPLITUDE AND PHASE CHARACTERISTICS OF AN INTERFERENCE MODULATOR OF LIGHT. I.I.Adrianova, Yu.V.Popov and A.V.Lapina.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 501-4 (Oct., 1960). In Russian.

Gives the results of theoretical and experimental studies of the amplitude and phase characteristics of a high-frequency interference modulator based on Michelson's interferometer fitted with two mirrors, one of which was vibrated piezoelectrically. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 260-2 (Oct., 1960)].
A.Tybulewicz

2880 USE OF THE WOLLASTON PRISM AS BEAM-SPLITTER IN SHEARING INTERFEROMETERS. W.Bartholomeyczyk.
Z. InstrumKde (Germany), Vol. 68, No. 9, 208-13 (Sept., 1960). In German.

Expressions are obtained for the directions of the split beams in terms of the original angles of incidence on the prism face. For a

quartz Wollaston with nominally 0.5° splitting angle, the actual splitting angle varies by 4% over a 20° range of angles of incidence.
W.T.Welford

MODIFIED DOUBLE SLIT INTERFEROMETER FOR SHOCK WAVE INVESTIGATIONS. See Abstr. 2781

2881 DEVELOPMENTS IN OUR CONCEPTS OF DIFFRACTION PHENOMENA. (ON THE 130TH ANNIVERSARY OF THE DEATH OF THOMAS YOUNG). G.D.Malyuzhinets.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 2, 321-34 (Oct., 1959).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 5, 749-58 (Sept.-Oct., 1959).

Historical survey. An analogy with diffusion of heat is introduced to explain qualitatively the variations in wave amplitude in a diffracted wave.
W.T.Welford

2882 MAXIMUM OF THE FACTOR OF ENCIRCLED ENERGY. G.Lansraux and G.Boivin.
Canad. J. Phys., Vol. 39, No. 1, 158-88 (Jan., 1961).

It is recognized that the most favourable distribution of radiant energy in a diffraction pattern is that which corresponds to the best concentration around the centre O. This hypothesis is expressed by an extremal condition on the factor of encircled energy E(W), that is, the ratio of the energy inside a circle of radius W and centred on the diffraction pattern, to the total energy in the same. A study of the effects of spherical aberration on this factor of encircled energy has shown that aberration always tends to decrease the factor from the value obtained with an Airy pattern. However, this factor may be increased by the use of an amplitude filter at the pupil of the optical system. In treating the case of amplitude filters one may use a rigorous analysis in terms of Taylor's series in $(1 - x^2)p^{-1}$ or a polynomial $T_n(x)$ of degree $n - 1$ in terms of $(1 - x^2)$. The corresponding amplitudes in the diffraction pattern are $\Gamma(W)$ and $\Gamma_n(W)$; the maximum factor of encircled energy $E(W_m)$ and $E_n(W_m)$. The following convergences are established: $E_n(W_m) \to E(W_m)$, $T_n(x) \to T(x)$, and $\Gamma_n(W) \to \Gamma(W)$ as $n \to \infty$. When the interval $(0, W_m)$ of the diffraction pattern is made to correspond to the interval $(0, 1)$ of the pupil by means of a suitable normalization the amplitude distributions $T(x)$ and $\Gamma(W)$ — with $W = W_m x$ — are identical. Some properties are deduced from this relation; for example, the Airy pattern is the limit of $\Gamma(W)$ when $W_m \to 0$; on the other hand, the Gauss function $e^{-(Wm/2)x^2}$ is an asymptotic expression of $T(x)$ when $W_m \to \infty$. In any case, the factor of encircled energy is connected to the marginal amplitude in the pupil by the relation $E(W_m) = 1 - T^2(1)$. The numerical determination of $E(W)$ given up to $W = 10$ and $W_m = 2$, 3, 4, and 5 can be extended by use of an asymptotic expression of the factor of encircled energy. Finally, a curve $M(W)$ is obtained, which is an envelope of the curves $E(W)$ corresponding to various values of W_m. This gives the locus of the maximum factor of encircled energy and represents the limiting performance of optical systems.

2883 THEORY OF THE ELLIPSOIDAL CONCAVE GRATING. I. T.Namioka.
J. Opt. Soc. Amer., Vol. 51, No. 1, 4-12 (Jan., 1961).

The grating has a circle as the focal curve which is similar to the Rowland circle in the spherical concave grating mounting. The grating equation is also the same as that of the spherical concave grating. By proper choice of lengths of the semi-axes of the ellipsoid, images are made nearly stigmatic and the optimum grating width is made wider than that of the spherical grating in a limited wavelength region. Comparison of optical properties of the ellipsoidal concave grating with those of the spherical concave grating is also shown graphically. The only difficulty in utilizing the ellipsoidal grating is the technical problem in ruling the gratings and in preparing the proper blanks.

2884 THEORY OF THE ELLIPSOIDAL CONCAVE GRATING. II. APPLICATION OF THE THEORY TO THE SPECIFIC GRATING MOUNTINGS. T.Namioka.
J. Opt. Soc. Amer., Vol. 51, No. 1, 13-16 (Jan., 1961).

The treatment of the preceding paper is applied to the Seya—Namioka monochromator and the grazing incidence spectrograph. Numerical data which are considered to be useful in designing the instruments are presented in the form of graphs and tables.

2885 SCATTERING BY A GRATING. I. R.F.Millar.
Canad. J. Phys., Vol. 39, No. 1, 81-103 (Jan., 1961).

Consideration is given to scattering of plane waves by a transmission grating upon whose elements the wave function vanishes. By an application of Green's theorem, the problem is formulated in terms of integral equations for a finite, or infinite, number of elements. The equations are put in a form more suitable for the study of interaction phenomena by the subtraction of a certain series. The modified equations then correspond, more or less, to the excitation of each element of the grating by the incident field, and two plane waves propagated in opposite directions along the grating. A solution is here attempted only for the infinite grating of identical elements. Attention is confined to the region of "Rayleigh wavelengths", where interaction is important, and the variation in spectral intensity for a grating of elements of arbitrary form is discussed in a semiquantitative manner; the existence of anomalies is inferred. An explicit solution is obtained for small scatterers of elliptical cross-section, and the behaviour of the spectral intensity is considered in some detail.

2886 SCATTERING BY A GRATING. II. R.F.Millar.
Canad. J. Phys., Vol. 39, No. 1, 104-18 (Jan., 1961).

The analysis of Pt I is repeated for the second boundary value problem in which the normal derivative of the wave function vanishes on the elements of the grating; the existence of anomalies is again inferred. The behaviour of the spectral intensity near an anomaly for a grating of small elliptic cylinders is considered and found to be much different from the case studied in Pt I. The infinite reflection grating is discussed. Weak anomalies are predicted in the spectra for the case in which the wave function vanishes on the grating; strong (Wood) anomalies are found in the spectra for the second problem. The finite transmission grating is treated very approximately. Anomalous behaviour, dependent now on the number of elements is inferred.

2887 MICROWAVE ANALOG TO THE SCATTERING OF LIGHT BY NONSPHERICAL PARTICLES.
J.M.Greenberg, N.E.Pedersen and J.C.Pedersen.
J. appl. Phys. (USA), Vol. 32, No. 2, 233-42 (Feb., 1961).

A microwave technique has been developed for obtaining total cross-sections and angular distributions for the scattering of electromagnetic radiation by nonspherical particles whose size is of the order of the wavelength. The scattering by spheroidal and cylindrical refracting particles was measured for three orthogonal orientations of the symmetry axis. Comparison of the results with exact and approximate theoretical calculations for spheres, spheroids, and finite and infinite cylinders indicates the possibility of developing useful approximation methods. Some interesting effects are noted, particularly a very large resonance in the scattering by finite cylinders. The results are applied preliminarily to the problem of the nature of interstellar material which absorbs and polarizes starlight.

2888 SCATTERING OF LIGHT BY DIELECTRIC ELLIPSOIDS OF SIZE COMPARABLE WITH WAVELENGTH. II. DEPENDENCE OF THE SCATTERING FUNCTION ON THE DIMENSIONS, SHAPES AND ORIENTATIONS OF THE ELLIPSOIDS. THE SCATTERING COEFFICIENT. A.V.Shatilov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 233-43 (Aug., 1960).
In Russian.

For Pt I, see Abstr. 19447 of 1960. Discusses the case of an arbitrarily oriented anisotropic ellisoid and the scattering function for prolate and oblate ellipsoids. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 233-43 (Aug., 1960).
A.Tybulewicz

2889 LIGHT SCATTERING BY INFINITE CYLINDERS. SPIDER FIBRES.
E.Matijević, R.H.Ottewill and M.Kerker.
J. Opt. Soc. Amer., Vol. 51, No. 1, 115-16 (Jan., 1961).

The polarization ratio of light scattered from a spider fibre was measured at scattering angles of 75°, 90° and 105° and the radius of the fibre was deduced from the scattering formulae, assuming refractive index 1.5. The 90° results agreed within 9% with the value, 112 mμ, obtained from electron microscopy.
W.T.Welford

2890 MIE SCATTERING FUNCTIONS FOR REFRACTIVE INDEX OF 2.105. M.Kerker and E.Matijević.
J. Opt. Soc. Amer., Vol. 51, No. 1, 87-92 (Jan., 1961).

Values of intensity functions and total scattering coefficient are presented for m = 2.105 and α = 0.2(0.4) 5.8; 6.0(0.2) 15.0. The applicability of Penndorf's approximate methods to the total scattering coefficient is discussed.

2891 THE RAMAN SCATTERING FUNCTION. N.K.Sidorov.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 546-7 (Oct., 1960). In Russian.

Plachek's formulae for the Raman scattering function are derived simply for polarized and unpolarized light. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 289 (Oct., 1960)]. A.Tybulewicz

2892 DETERMINATION OF PARTICLE SIZE FROM SCATTERING OF LIGHT. NOMOGRAMS FOR DETERMINATION OF SIZE OF ROD-SHAPED PARTICLES. I.Ya.Slonim.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 244-7 (Aug., 1960). In Russian.

Presents two nomograms for calculation of the size of rod-like particles by two methods: either using measurements of turbidity in transmitted light or measurements of scattered-light distribution. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 127-9 (Aug., 1960)]. A.Tybulewicz

LIGHT SCATTERING ON ABSORBING AND DIELECTRIC PARTICLES. APPLICATION TO ZODIACAL LIGHT. See Abstr. 2609

2893 PHOTOELECTRIC POLARIMETER WITH A ROTATING PHASE PLATE. J.Leray and G.Scheibling.
C.R. Acad. Sci. (France), Vol. 251, No. 5, 677-8 (Aug. 1, 1960). In French.

An instrument is described in which the detector is a photomultiplier and the current is modulated by a weakly birefringent plate rotating about an axis along the light direction. The required optical rotation is obtained either from a measurement of the amplitude or of phase. Adjustment is made to get a null setting. (See also Abstr. 19454 of 1960). H.G.Jerrard

2894 AN APPARATUS FOR THE MEASUREMENT OF CIRCULAR DICHROISM IN THE VISIBLE AND THE ULTRA-VIOLET. M.Grosjean and M.Legrand.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2150-2 (Nov. 14, 1960). In French.

A brief description of the apparatus is given. In this a linearly polarized beam passes through a monoammonium phosphate plate cut perpendicularly to the optic axis. The crystal is subjected to an alternating electric field, which is set to such an intensity, so that with the crystal suitably orientated, the emergent beam is alternately left and then right circularly polarized. The modulated beam then traverses the solution under test where each circularly polarized component is differently attenuated and the resultant beam falls on a photomultiplier. The output current has an a.c. and a d.c. component V_c. The former is rectified to give a d.c. component V_d and the ratio V_d/V_c is recorded. This ratio is given by the expression $2\pi K(\chi_g - \chi_d)lc/\lambda$, where c is the concentration, l the path length, λ the wavelength, χ_g and χ_d the molecular extinction indices and K a constant determined by calibration with a solution of known dichroism. Results have been obtained over the wavelength range 2 200 to 6000 A. H.G.Jerrard

VAVILOV–CHERENKOV EFFECT IN UNIAXIAL CRYSTALS. See Abstr. 2035

COLORIMETRY . PHOTOGRAPHY

2895 METHODS OF RAISING THE EFFECTIVE SENSITIVITY OF THE PHOTOGRAPHIC SYSTEM. K.V.Chibisov.
J. photogr. Sci. (GB), Vol. 9, No. 1, 26-35 (Jan.-Feb., 1961).

Consideration of the variations in the rate of growth of sensitivity since the invention of photography, of the factors which come into play in emulsion making, and of modern ideas on photographic sensitivity, leads to the belief that there is little prospect of any spectacular increase in the speed of conventional silver halide materials. At present the non-silver-halide systems have not been sufficiently developed to allow a prediction of possible speed increases. Electronic systems used in conjunction with photographic systems make possible a speed increase of two or three orders of magnitude, but with a considerable loss of picture quality.

REMOVAL OF SCREEN STRUCTURE FROM PHOTOGRAPHS BY OPTICAL FILTERING. See Abstr. 1832

2896 METHOD OF INVESTIGATION DURING THE FORMATION OF THE LATENT IMAGE BY A SIMULTANEOUS EXPOSURE TO RED LIGHT. R.Schmitt and P.Cüer.
C.R. Acad. Sci. (France), Vol. 251, No. 10, 1124-6 (Sept. 5, 1960). In French.

Emulsion were exposed to ultraviolet light for $< 10^{-6}$, 3×10^{-4} and 12 sec. By steady movement over a slit, parts of the plate were illuminated with infrared light before, during and after the u.v. exposure. The variation of density with time was therefore obtained and suggested a phase of latent image formation lasting up to 90 sec. E.J.Burge

AUTOMATIC SILVER CONCENTRATION CONTROL FOR NUCLEAR EMULSION FIXING BATHS. See Abstr. 2000

2897 MODERN TRENDS IN CINÉ LENSES. G.H.Cook.
Brit. Kinematogr., Vol. 37, No. 6, 140-53 (Dec., 1960).

The criteria of performance of ciné lenses are discussed in terms of resolution, edge sharpness and frequency response. Lens design is now able to reach higher levels of aberration correction by the use of electronic computors. A typical lens design is discussed and the improvements obtained by re-computation are shown. R.W.Fish

AN INSTRUMENT FOR MEASURING ANGLES ON CURVED PHOTOGRAPHIC PLATES. See Abstr. 2590

HEAT . RADIATION

2898 ANALYTICAL TREATMENT OF SIMPLE UNSTEADY-STATE HEAT PROBLEMS. B.Rusjan.
Elettrotecnica (Italy), Vol. 46, No. 8, 474-87 (Aug. 10, 1959). In Italian.

After a brief summary of the basic foundations of heat conduction, heat phenomena in a wall are compared with electrical phenomena in a loss-free cable, and the Benken model, i.e. an electrical model of unsteady state heat problems, is arrived at. The author deduces the errors which arise from various approximations and simplifications and shows the method for solving practical problems. Two practical problems confirm the validity and elegance of the analytical method. A.E.I. Research Laboratory

2899 STUDY OF THE THERMAL EXCHANGES BETWEEN THE FLUID AND THE SOLID PARTICLES IN FLUIDIZED MEDIA. G.A.Donnadieu.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 51, 161-9 (June, 1960). In French.

The general differential equations for the temperature distribution in a fluidized layer are established. Those applicable to the particular case of an inert fluidized bed in the transitory regime are integrated and expressions are obtained for the temperatures, as a function of time and position, for the fluid and solid. In the apparatus described the bed studied was in an adiabatic enclosure and a series of thermocouples was used to measure the temperature at different levels. The fluid was air and the solid glass. Measurements were made to verify the theory and to find the relationship between the thermal convection and the fluid flow. For $Re < 10$, $Nu = 0.0087\ Re^{2.3}$, but for $Re > 10$ the the value of Nu decreases steadily with increasing Re from the value given by the equation. S.Weintroub

2900 CONCERNING THE CALCULATION OF RAPID TRANSPORT OF HEAT. P.Vernotte.
C.R. Acad. Sci. (France), Vol. 251, No. 14, 1354-5 (Oct. 3, 1960). In French.

A problem suggested by the re-entry of a projectile into the atmosphere is reduced to a differential equation involving a two-point boundary condition. The equation is solved as a series. The problem of determining the coefficient of the first term is tackled by an "interpolation" process. H.N.V.Temperley

2901 PULSE METHOD FOR THE MEASUREMENT OF THERMAL DIFFUSIVITY OF METALS. E.L.Woisard.
J. appl. Phys. (USA), Vol. 32, No. 1, 40-5 (Jan., 1961).

A pulse method for measuring thermal diffusivity of metals has been developed. The temperature in an effectively infinite rod is zero everywhere up to the time t = 0, when a very short heat pulse is introduced in the plane x = 0. The subsequent temperature histories of several points at different distances from x = 0 are recorded, and from these data the thermal diffusivity may be calculated. Since an experimental run lasts less than one minute, the requirements on the stability of the ambient temperature are not as stringent as in previously reported methods. The present method saves time without sacrificing accuracy, a maximum error of ±4% being estimated. Although the work was carried out at room temperature, the specimens were mounted in a vacuum furnace which should permit measurements at elevated temperatures. The method was tested on commercial "A" nickel, giving a result in excellent agreement with previous values. Results are reported for new steels developed by the Bethlehem Steel Company.

2902 TRANSIENT RESPONSE OF A THERMOCOUPLE CIRCUIT UNDER STEADY CURRENTS.
A.D.Reich and J.R.Madigan.
J. appl. Phys. (USA), Vol. 32, No. 2, 294-301 (Feb., 1961).

Heat transfer calculations for a thermocouple circuit functioning as a Peltier cooler have been carried out. The calculations depend upon the exact solution of a one-dimensional time-dependent heat equation. It is shown that for an unloaded couple the temperature at the cold junction will be less than or equal to the reference junction temperature only for currents in the range from zero to twice the optimum current (i.e. the current that produces the minimum cold junction temperature). The temperature at the cold junction has been investigated as a function of time, and shown to approach the steady-state values appropriate to any particular multiple of the optimum current at that point with increasing time. It has been shown that one cannot produce a transient thermal spike at the cold junction which is greater in magnitude than the steady-state temperature for the optimum current by initially applying currents greater than the optimum. The possibility of achieving such thermal spikes by superposing a current pulse upon the steady-state current is discussed. The possibility of using the transient response of thermocouple junctions for the measurement of thermal conductivity is examined.

THE SOLUTION OF THE NON-STATIONARY THERMAL CONDUCTIVITY PROBLEM FOR A ROD, ON THE ENDS OF WHICH ARE ATTACHED TWO MASSES. See Abstr. 2429

2903 DENSITY FLUCTUATIONS AND HEAT CONDUCTION IN A PURE LIQUID. R.E.Nettleton.
Phys. of Fluids (USA), Vol. 4, No. 1, 74-84 (Jan., 1961).

Two components of the heat flux in a pure liquid are identified — one carried by sound waves and the other by diffusing molecules. Coupled relaxation equations are obtained for these components, both depending on the density gradient $\nabla\rho$, and this dependence is interpreted thermodynamically as a further coupling of these equations with the equation determining $(\partial/\partial t)(\nabla\rho)$. The latter can be immediately written down with the aid of Onsager's theorem and an inertial principle developed in a previous paper. The thermodynamic interpretation of these rate equations also leads to an explicit expression for the coefficient of $(\nabla\rho)^2$ in a Taylor expansion, about equilibrium, of the Helmholtz free energy. This result is compared with similar free-energy terms assumed to exist by other authors.

2904 EFFECT OF SPECULAR REFLEXIONS ON THE RADIATION FLUX FROM A HEATED TUBE.
K.S.Krishnan.
Nature (GB), Vol. 188, 652-3 (Nov. 19, 1960).

Corrects an error in a previous paper (Abstr. 14877 of 1960). For the example given, of walls with emissivity $\epsilon = 0.75$ (the fraction $1 - \epsilon$ of incident radiation being specularly reflected) the flux from the mouth of a cylinder, closed at the other end and of length five times the diameter, is only 0.23% less than from a black body. The general conclusions still hold. R.Berman

2905 SPECTRAL DISTRIBUTION OF RADIANT ENERGY. R.A.Sapozhnikov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 2, 387-90 (Feb., 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 1, 172-4 (July-Aug., 1960).

Various methods of representation of the spectral distribution are discussed, with particular reference to the search for a spectral scale in which the maximum of the spectral density is at the position of maximum flux. S.Weintroub

A FAR-INFRARED BIBLIOGRAPHY. See Abstr. 2855

2906 COMPARISON OF THE TEMPERATURE SCALES OF VARIOUS LABORATORIES IN THE 600-3500°C RANGE.
W.A.Heusinkveld.
Electrotechniek (Netherlands), Vol. 38, No. 21, 536-39 (Oct. 13, 1960). In Dutch.

Thermocouples that had already been calibrated in different national standards laboratories were compared at temperatures of 600-1100°C using an electric furnace. The differences were $<1^\circ$ at 1063°C. In addition, the temperatures of some tungsten strip-lamps in the 1250-2500°K range (luminance temperatures) were compared. These lamps had been calibrated at the N.P.L., the Physikalisch-Technische Bundesanstalt and three physical laboratories in Holland. The deviations in the calibrations were $<6^\circ$ at 2500°K. The luminance temperature of the anode of a carbon arc was determined by means of a pyrometer, and found to be 3808 ± 15°K. G.N.J.Beck

2907 THE MEASUREMENT OF TEMPERATURE WITH ELECTRIC RESISTANCE THERMOMETERS.
V.Manassi.
Elettrotecnica (Italy), Vol. 46, No. 8, 503-6 (Aug. 10, 1959). In Italian.

Summarizes the main properties of resistance thermometers. Diagrams show a number of protective cases. After calibration the best instruments have an accuracy of better than 0.02°C from −50° to +150°C, and better than 0.1°C from −200° to +500°C. Tolerances are quoted for platinum and nickel elements. It is concluded that the resistance thermometer is technically preferable to other methods of measurement in most practical cases. N.G.Batty

2908 TEMPERATURE MEASUREMENT BASED ON THE VISCOUS FLOW OF GAS IN A WHEATSTONE-BRIDGE NETWORK. H.J.Hoge.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 1-6 (Jan., 1961).

A Wheatstone-bridge arrangement of capillary tubes carrying a flow of inert gas is described, with which the resistance to flow of a capillary tube serving as a thermometer may be measured. The resistance is shown to be proportional to the product $T\eta$, for constant mass rates of flow in the viscous regime. Gas-viscosity thermometers have relatively open and linear scales, and are usable over wide temperature ranges. With helium gas, for example, the product $T\eta$ varies strongly and smoothly with temperature from below 1° to above 1500°K and probably much farther. Experimental tests of Al_2O_3 capillary thermometers in a high temperature furnace are reported. Some of the thermometers were reasonably stable at 1788°K.

2909 TESTS AND COMPARISONS OF CARBON AND GERMANIUM THERMOMETERS. P.Lindenfeld.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 9-11 (Jan., 1961).

Two encapsulated germanium thermometers were calibrated and tested between 1.4° and 4.2°K. Within the precision of the measurements (±0.4 millidegree) no change in their calibration was found after cycling to room temperature or after temporary removal from the measuring apparatus. In this respect, the germanium thermometers were considerably better than carbon thermometers. For comparison a carbon thermometer was encapsulated and found to undergo unpredictable changes corresponding to several millidegrees under similar circumstances.

2910 CALORIMETRIC MICROBOMB SUITABLE FOR E.CALVET'S TYPE OF MICROCALORIMETER.
E.Calvet, P.Chovin, H.Moureu and H.Tachoire.
J. Chim. phys. (France), Vol. 57, No. 7-8, 593-6 (July-Aug., 1960). In French.

The microbomb, with its thermal diffusivity suitably adapted to that of Calvet's microcalorimeter, can be used for the measurement of the heats of combustion of small quantities (milligrams) of substances and thus for calibration with the international standard. The construction and method of use of a cylindrical microbomb are described in some detail, and it is emphasized that the interior walls of the microbomb should be covered by a thermally insulating layer.
S.Weintroub

2911 LECTURE EXPERIMENT ON THE DETERMINATION OF THE SPECIFIC HEAT OF A GAS AT CONSTANT PRESSURE. S.N.Sokolov and L.N.Erastov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 2, 379-80 (Feb., 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 1, 171 (July-Aug., 1960).

An all-glass apparatus, using the continuous flow method and electrical heating, is described. The experiment takes about 10 min to perform.
S.Weintroub

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

2912 MECHANISM OF BOILING UNDER ELECTRIC FIELD. E.Bonjour and J.Verdier.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 924-6 (Aug. 17, 1960). In French.

Photographs of the surfaces of heated wires in Freon boiling at atmospheric pressure in the presence of an electric field have established the existence of an electromechanical action on the movement of the bubbles in accordance with the analysis outlined in previous papers (ibid, Vol. 250, 76 (1960); Abstr. 10663 of 1960).
S.Weintroub

2913 MEASUREMENT OF TELLURIUM VAPOUR PRESSURE USING ELECTRICAL DISCHARGES.
J.C.Brice.
J. sci. Instrum. (GB), Vol. 37, No. 12, 491-2 (Dec., 1960).

Describes measurements of the variation of the current—voltage characteristics of a particular discharge in tellerium vapour with p, for $3 < p < 40$ torr.
J.Dutton

VAPOUR PRESSURE OF LEAD AND GERMANIUM SULPHIDES. See Abstr. 1849

2914 SOME REMARKS ON THE BORN—GREEN—RODRIGUEZ THEORY OF CONDENSATION. K.Ikeda.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 616-28 (April, 1960).

An attempt is made to clarify the discrepancy in the singular point between the condensation theory of Born—Green—Rodriguez (BGR) (1946-9), using the integral equation method and that of Mayer (1937-40), using the series expansion method. The BGR theory is interpreted as an approximate theory in which Mayer's "frame" is replaced by the "ring". In the framework of Mayer's theory, it is shown that the maximum point of the BGR gas is absolute zero, and that the singular point of the BGR isotherm is analytically explainable but has no physical meaning. By applying the results of the author's previous work to this case, the two-phase separation (the appearance of a "huge" cluster) and the horizontal line (starting from the maximum point of the isotherm) are deduced. Some further problems on the condensation theory are discussed: (1) a note on the integral equation method; (2) the different interpretations of an approximation; the rule of equal areas; van der Waals' equation; (3) the analytical properties of the condensation point; (4) the analytical behaviour of condensing systems; (5) the ideal Bose—Einstein gas.

THERMODYNAMICS

(See also Statistical Mechanics)

2915 ZEROTH LAW OF THERMODYNAMICS. L.A.Turner.
Amer. J. Phys., Vol. 29, No. 2, 71-6 (Feb., 1961).

The following is shown with respect to the zeroth law: (1) Planck's argument that it follows from a general theorem concerning establishment of thermal equilibrium among numerous bodies does not appear to be conclusive. (2) The zeroth law is a consequence of the first and second laws in classical thermodynamics and need not, therefore, be considered as a separate assumption or law. (3) The zeroth law must be assumed as supplementary to the second axiom in Caratheodory's theory, as Caratheodory did, if one wishes to adhere to that axiom precisely as he gave it. If, however, the axiom be amplified slightly in a natural way, the zeroth law can be derived as a consequence.

LOW-TEMPERATURE PHYSICS

2916 SIXTH ALL-UNION CONFERENCE ON LOW TEMPERATURE PHYSICS. R.Chentsov.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 2, 339-47 (June, 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 457-65 (Nov.-Dec., 1960).

Held in Sverdlovsk, on 27 June to 2 July, 1959. About fifty papers were presented devoted, inter alia, to superconductivity, polymorphism, electronic properties of metals, liquid He and semiconductors.

2917 PROCEDURE FOR COOLING SAMPLES IN CALORIMETRY AT VERY LOW TEMPERATURES.
J.Aslanian and L.Weil.
C.R. Acad. Sci. (France), Vol. 251, No. 15, 1468-70 (Oct. 10, 1960). In French.

Describes an arrangement consisting of a metallic bellows actuated by pneumatic control for making and breaking thermal contact by mechanical means in systems at liquid helium temperatures.
S.Weintroub

MUTUAL INDUCTANCE BRIDGE FOR CRYOGENIC MEASUREMENTS. See Abstr. 2925

LOW-TEMPERATURE COMPARISON OF CARBON AND GERMANIUM RESISTANCE THERMOMETERS. See Abstr. 2909

Liquid and Solid Helium

2918 SELF-DIFFUSION IN LIQUID He^3. D.Hone.
Phys. Rev. (USA), Vol. 121, No. 3, 669-73 (Feb. 1, 1961).

The Landau model of a Fermi liquid is employed to obtain an expression for the coefficient of self-diffusion, D, in liquid He^3. It is found that $D = A/T^2$, where $A \cong 2 \times 10^{-6}$ cm^2 sec^{-1} deg^2, and T is the temperature in degrees Kelvin. As this temperature dependence differs from that experimentally observed ($T^{-3/2}$), (Abstr. 5230, 19542 of 1960), although the order of magnitude of the theoretical prediction agrees well with experiment, the possible effect of the 1% He^4 impurity known to be present is investigated; it is found that the diffusion coefficient is essentially unaffected by the impurity (a result also obtained experimentally). It is estimated that the Landau model is applicable only well below 0.05°K. As even the most recent experiments have been carried out only down to 0.03°K, it is concluded that the transport properties of He^3 should be investigated experimentally at lower temperatures in order to check the validity of the theory.

2919 NUCLEAR PARAMAGNETIC SUSCEPTIBILITY OF THE POSSIBLE LOW-TEMPERATURE PHASE OF LIQUID He^3. L.H.Nosanow and R.Vasudevan.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 1-3 (Jan. 1, 1961).

Critical field phenomena are predicted. It is found quite generally that there is a critical magnetic field, although of the orde of 10^6 G. The theory predicts a sharp drop in the susceptibility at the critical temperature.
K.G.Major

Superconductivity

2920 ELECTRON PAIRS IN THE THEORY OF SUPERCONDUCTIVITY. J.M.Blatt.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 447-50 (March, 1960).

The detailed mathematical correspondence between the Bogolyubov theory and the quasichemical equilibrium theory is established by means of identities. The Bogolyubov–BCS Ansatz is a special case of the quasichemical equilibrium Ansatz, corresponding to perfect Bose–Einstein condensation of the electron pairs.

2921 EFFECT OF RESIDUAL GASES ON SUPERCONDUCTING CHARACTERISTICS OF TIN FILMS. H.L.Caswell.
J. appl. Phys. (USA), Vol. 32, No. 1, 105-14 (Jan., 1961).

A special oil-free, ultra-high vacuum system was used to deposit tin films at pressures less than 10^{-9} mm Hg on to room temperature substrates. These films were found to possess extremely sharp and reproducible magnetic field transitions as compared to films deposited by more conventional techniques. This resulted from breakup of the penumbra of a film deposited through a mask into electrically discontinuous islands leaving a film of uniform thickness. Specific residual gases were found to decrease the surface mobility of the tin atoms which contributed to continuous film edges and higher critical fields. For example, the critical field extrapolated to 0°K increased from 370 Oe for a pure film to 490, 590, and 820 Oe as the ratio of oxygen molecules to tin atoms striking the substrate increased from 0 to 3, 6, and 9% respectively. For more highly doped films, the bulk characteristics were also altered, indicating the presence of oxygen in the film material. Water vapour and carbon dioxide were found also to alter the edge structure, whereas N_2, H_2, CH_4, C_3H_8, C_5H_{12}, A, and CO did not. By analysing the critical field and residual resistance data of the various films, the vacuum requirements necessary for obtaining high purity films with sharp magnetic transitions occurring at predictable field values were ascertained. An ultra-high vacuum system is not required if the partial pressure of critical gases is maintained below specified values.

2922 NUCLEAR MAGNETIC RESONANCE IN SUPERCONDUCTING TIN. G.M.Androes and W.D.Knight.
Phys. Rev. (USA), Vol. 121, No. 3, 779-87 (Feb. 1, 1961).

The nuclear magnetic resonance was investigated in small particles (~ 100 A diameter) of β-tin between 1.5° and 4.2°K, and in magnetic fields between 1.2 and 8.8 kG. The critical temperature and critical field are 3.71°K and 25 kG, respectively. The effective penetration depth for the superconducting particles is estimated to be 1500 A. The resonance linewidth is 0.34% of the magnetic field, and it is independent of temperature. With respect to α-tin, the n.m.r. shift for β-tin is 0.77% in the normal state; it approaches 0.59% in the superconductor as $T \rightarrow 0$. (The largest known chemical shift is only 0.17%). The variation with magnetic field is less than 0.03%. One may conclude that the electronic spin susceptibility in the superconducting particles at absolute zero is approximately three-quarters of the normal value. The result for 1000 A particles, though less accurate, is substantially the same.

2923 LIMITING VALUE OF DEBYE TEMPERATURE FOR SUPERCONDUCTING AND NORMAL INDIUM FROM LOW-TEMPERATURE ELASTIC CONSTANTS.
B.S.Chandrasekhar and J.A.Rayne.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 3-4 (Jan. 1, 1961).

The elastic constants of In are found to differ by less than 1 part in 10^4 between the normal and superconducting states. It is concluded that the Debye temperature (computed to be $111.3 \pm 1^{\circ}$K) is the same for the two states, contrary to the report of Bryant and Keesom (Abstr. 13489 of 1960). R.G.Chambers

COMPENSATION PRINCIPLE AND THE SELF-CONSISTENT FIELD METHOD. See Abstr. 2714

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

2924 STEPLESS VARIABLE RESISTOR FOR HIGH CURRENTS. C.R.Yokley and J.B.Shumaker, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 6-8 (Jan., 1961).

A variable-area water rheostat has been applied to the problem of current control in electric arc and plasma generating equipment. Resistance between 0.5 and 30 ohms can be obtained b adjusting the height of circulating water which surrounds pairs of fixed vertical aluminium plates. The electrolyte is ordinary mains water which is circulated through the tank and discharged. No special filtering, pumping, or other treatment is used. The unit is located in the open air outside the laboratory and all control functions are operated from a remote switching panel. Th unit has been operated using a maximum of 125 A at 400 V d.c. anc 1000 A at 230 V d.c.

2925 DESIGN OF MUTUAL INDUCTANCE BRIDGE FOR CRYOGENIC MEASUREMENTS. L.D.Jennings.
Rev. sci. Instrum (USA), Vol. 31, No. 12, 1269-74 (Dec., 1960).

It is shown that a mutual inductance bridge may be designed whose components are small and which allows a magnet to be placed around the unknown with no loss in sensitivity and accuracy. An instrument which embodies these principles is described, and techniques are given for obtaining accurate and rapid measurement of the real and imaginary components of the unknown.

RECORDING INTEGRATOR FOR GAS CHROMATOGRAPHY. See Abstr. 2561

TRANSISTORIZED VACUUM TRIP UNIT. See Abstr. 2802

2926 CONSTANT CURRENT SUPPLY FOR VERY HIGH RESISTANCE LOADS. R.W.Haisty.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1297-8 (Dec., 1960).

A solid-state constant-current supply which operates in the current range of 1 to 100 μA with load resistances up to several hundred megohms is described. The system is battery-operated, and allows one side of the load resistance to be grounded. The current is controlled by a gallium arsenide photoresistor in series with the load. The load current is balanced against a standard current and the difference is fed to a chopper-amplifier which drive a small lamp focused on the photoresistor. The gain of the amplifier is sufficiently high that a very small unbalance in curren will drive the lamp to full output; thus, the photoresistor keeps the lo current very near the standard current for any value of load resistance from zero up to the dark resistance of the photoresistor typically about 8×10^8 ohms.

2927 CALIBRATION OF A CHRONOTRON WITH THE AID OF A ROSENBLUM PULSE GENERATOR.
J.Duclos and J.Fleury.
J. Phys. Radium (France), Vol. 19, Suppl. No. 4, 48A-50A (April, 1958). In French.

A fast neutron spectrometer using the time-of-flight method is described. The transit of two pulses passing in opposite directions down two similar delay lines is determined by a multi-channel coincidence circuit incorporated in the delay lines In order to test the resolution of the system a Rosenblum (corona) counter was used to generate pulses with 2.5×10^{-9} sec rise time 400 p.p.s. The resolving time of the chronotron was found to be 5×10^{-10} sec. A.E.I. Research Laborato

2928 THE NOISE OF UNDAMPED TUNED CIRCUITS.
H.Pfeifer and O.Rothe.
Exper. Tech. der Phys. (Germany), Vol. 8, No. 3, 112-17 (1960). I German.

For the measurement of nuclear paramagnetic resonance it wa desired to verify that an expression for the r.m.s. noise of a tuned circuit in a high-gain amplifier was valid for the case of reduced damping. The triode section of an ECF82 was used as the input stage (equivalent resistance = 320 Ω). The 2nd stage (pentode sec-

ion of ECF82) has an equivalent noise resistance of 1 kΩ. Three more pentode stages and a cathode follower gave the amplifier a gain of 10^6 at a centre frequency of 10.7 Mc/s, and a bandwidth of 100 kc/s. The reduction of damping was by feedback through a cathode follower. Variation of the cathode follower screen voltage allowed measurements to be made with various values of effective Q. For a range of Q up to 1000, the measured noise was within 10% of that calculated from the general formula. W.G.Stripp

2929 SYSTEM FOR OSCILLOGRAPHIC RECORDING OF SELECTED PULSES FROM A SERIES OF RANDOMLY ARRIVING IMPULSES. A.W.Trorey.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 62-4 (Jan., 1961).

When velocity logging oil wells, a sonde is raised from the bottom of the well borehole at a slow, but variable and unpredictable rate. This sonde transmits pulsed acoustic energy at a variable pulse repetition rate into the earth surrounding the borehole and, in addition, detects the refracted acoustic pulses after they travelled a few feet through the earth surrounding the borehole. In order to ascertain certain characteristics of the earth, it is desirable to record photographically those pulses occurring, not as specified time intervals, but at specified depth intervals. This is accomplished by converting the sonde depth to electrical gate pulses occurring at the desired depth intervals. These gate pulses are used to open a gate which permits only the fine acoustic pulse following a gate pulse to pass through the gate and be photographed on a triggered oscilloscope. The equipment is fully automatic in that the camera film is automatically advanced between recorded pulses and precautions are automatically taken to prevent double exposures. Similar instrumentation should be applicable to related problems involving the photographing of system responses as a function of some measurable parameter which varies slowly but unpredictably with time.

2930 A SIMPLE "TIME-TO-HEIGHT CONVERTOR" FOR TIME-OF-FLIGHT EXPERIMENTS WITH SLOW NEUTRONS. K.H.Beckurts.
Nukleonik (Germany), Vol. 2, No. 4, 129-31 (June, 1960). In German.

A circuit is described which enables the times of arrival of a train of pulses to be converted into a pulse-height distribution with the aid of a suitably triggered saw-tooth waveform. The resulting pulse-height distribution can then be analysed by a conventional pulse-height analyser. The equipment has been used successfully for "time-of-flight" measurements on slow neutrons.
A.E.I. Research Laboratory

2931 TIME OF FLIGHT SELECTOR WITH ELECTROSTATIC MEMORY.
Y.Amram, H.Guillon, C.Hugot and J.Thenard.
Nuclear Electronics Conference, Paris, 1958, Vol. I, (see Abstr. 12719 of 1960) p. 311-16. In French.

The memory is a barrier-grid storage tube, with horizontal deflection by a triangular wave and vertical deflection in steps. The horizontal sweep is stopped at predetermined points for 1 μsec. Various shapes of storage areas are compared. The only arithmetic operation to be performed is the addition of 1. This is done by seeking the lowest 0 in the binary number, changing it to 1 and changing all units to the right to 0. This is done in 0.2 μsec.
W.G.Stripp

2932 TRANSIENTS IN LOGARITHMIC COUNT-RATE AND PERIOD METERS. B.B.Barrow and R.Maitland.
Nuclear Electronics Conference, Paris, 1958. Vol. I (see Abstr. 12719 of 1960) p. 343-57.

Various differentiating networks are studied from the point of view of their ability to differentiate at low frequencies and attenuate at the higher frequencies representing noise. For each type of network, the parameters are determined for a 15 sec solution time to a ramp function. An experimental period-measuring circuit is given, and precautions necessary when working with a reactor are studied, using a reactor simulator. To avoid a response with too high a growth factor, a biasing diode current is required.
W.G.Stripp

2933 A 100 CHANNEL PULSE ANALYZER UTILIZING DUAL STEP CONVERSION. J.P.MacMahon.
Nuclear Electronics Conference, Paris, 1958. Vol. I (see Abstr. 12719 of 1960) p. 291-305.

The analyser uses an analogue-to-digital convertor in which an input pulse charges a capacitor to its peak voltage. The capacitor is then discharged in equal voltage steps until the potential is reduced to a predetermined value, when the discharge continues in steps 10 times smaller, thus giving easy interpolation. The steps are counted and stored for display against pulse height channel number on a c.r.t. The store is a magnetic core memory. Circuits are given for valve and transistorized decade scalers and reading amplifiers.
W.G.Stripp

2934 A VERSATILE PULSE HEIGHT ANALYZER UTILIZING PHOTO-PICK-UP SORTING OFF A C.R.T.SCREEN. R.V.Gåsström.
Nuclear Electronics Conference, Paris, 1958. Vol. 7. (see Abstr. 12719 of 1960) p. 317-31.

The principal methods of pulse height analysis are tabulated under pulse height conversion process, display and sorting process. Experiments in the use of photo-pick-up elements, with collimators and light guides, are described. Photo-transistors were found to be too temperature-dependent, but silicon photo-voltaic cells in conjunction with a transistor gave stable, linear results. Circuits of the discriminator and the d.c. coupled display system are given.
W.G.Stripp

2935 A THREE DIMENSIONAL ANALYZER USING DIGITAL RECORDING ON MAGNETIC TAPE.
J.R.Bird, J.R.Waters and F.H.Wells.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 87-8 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A digital analyser which records data on a 1 in. magnetic tape was constructed and used for several experiments. Recording is at slow speed, the analysis being at 100 in./sec. Recorded data are fed into a ferrite core memory, added up, and finally punched out on to paper tape or cards for processing by a computer. Three typical experiments are described which involve pulse-height analysis of scintillation-counter data and neutron time-of-flight information. These are measurement of fission neutrons from U^{235}, the spectra of neutron-capture gamma rays from platinum and the investigation of pulse-shape discrimination between neutrons and gamma rays for a plastic scintillator. Typical three-dimensional models of the data are shown.

2936 TRANSISTOR COUNTING SYSTEMS FOR SCINTILLATION DETECTORS.
S.C.Baker, H.G.Jackson and D.A.Mack.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 89-95 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The requirements for multiple-coincidence counting systems with 10^{-8} to 10^{-9} sec time resolution can be met economically with presently available h.f. transistors. The design of solid-state coincidence circuits, amplitude discriminators, and decade scalers is considered and their operation discussed. Several systems have been designed utilizing up to 180 channels from scintillation detectors.

2937 CONSIDERATIONS IN THE DESIGN OF PULSE AMPLIFIERS FOR USE WITH SOLID STATE RADIATION DETECTORS. E.Fairstein.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 129-39 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

The definition of amplifier noise in terms of equivalent charge or equivalent electrons and the technique for its measurement in these terms are discussed in detail. Some of the theory which relates to the design of low noise, highly stable pulse amplifiers is reviewed. Valves and other circuit elements suitable for use in low-noise amplifiers are discussed. The effect of the pulse shaping networks on the s/n ratio (shot noise and grid-current noise components) is described and data are given for the relative merits of single and double RC and delay-line clippers in association with 1 to 5 RC integrators. It is shown, for example, that the noise performance of the double delay line clipper is noticeably inferior to that of the single RC clipper, although it is very much better with regard to permissible counting rate.

2938 AMPLIFIERS FOR USE WITH P–N JUNCTION RADIATION DETECTORS.
R.L.Chase, W.A.Higinbotham and G.L.Miller.
IRE Trans Nuclear Sci. (USA), Vol. NS-8, No. 1, 147-50 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Gives one transistor and two valve preamplifier circuits for use with p–n junction radiation detectors. Noise versus external input-capacity graphs are presented.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

2939 INVESTIGATION OF FINITE DIFFERENCE EQUATIONS FOR POINTS SITUATED ON THE EDGE OF A SURFACE DISTRIBUTION OF CHARGES. THE CASE OF SYSTEMS OF REVOLUTION. J.Gélard.
C.R.Acad. Sci. (France), Vol. 251, No. 18, 1871-3 (Oct. 31, 1960). In French.

The method of Abstr. 5253 of 1960 is applied to points on the edges of the distributions discussed in Abstr. 12569 of 1960.
J.Hawgood

2940 ION TRANSPORT HIGH VOLTAGE GENERATORS.
O.M.Stuetzer.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 16-22 (Jan., 1961).

Ions are injected into an insulating liquid and pumped into a collector, which assumes a high potential. Results of a theoretical treatment of this arrangement are compared with experimental evidence. While the generator has low energy conversion efficiency, it possesses a number of compensating advantages.

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

2941 ON THE MACROSCOPIC ANALYSIS OF THE CONDUCTING ELECTROMECHANICAL SOLID WITH APPLICATION TO CYLINDERS SUBJECTED TO AXIAL ELECTRIC FIELDS. R.C.Geldmacher.
J. appl. Phys. (USA), Vol. 32, No. 2, 143-58 (Feb., 1961).

The ambient to melting phase of the solid is examined from the standpoint of intercoupled electrical, thermal, and mechanical effects in order to establish the foundations for a theoretical solution, and to establish the intervals over which the solution is valid. Thermoelectric and electromagnetic effects are considered relative to their influence on the distribution of temperature and electric field within the conductor. Body forces resulting from the electromagnetic field are also considered and the corresponding stresses worked out. The principal analytic result obtained is that for the nonlinear problem resulting from electrothermal coupling through temperature-dependent electrical conductivity. General solutions are obtained for conditions of no heat loss at the boundary, radiation at the boundary (Newton's law of cooling), and the boundary fixed at the initial temperature. Various examples of engineering interest are worked out and the results are compared with solutions obtained assuming constant electrical conductivity. It is found that significant electromechanical body forces may be present under certain circumstances and it is shown that these body forces may play an important part in the breakup of wires subjected to large, suddenly applied fields.

2942 EQUATIONS OF POTENTIAL AND TEMPERATURE FOR CONDUCTORS IN AN EXTERNAL MAGNETIC FIELD. H.Stachowiak.
Bul. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 6, 399-401 (1960).

A temperature field and a magnetic field are applied in the perpendicular direction to a thin plate. Assuming a homogeneous magnetic field and Onsager's coefficients independent of temperature, the potential difference between the corners of the plate is obtained. This yields a correction to the Nernst effect caused by electric current. J.K.Skwirzynsk

THE SOLUTION OF THE NON-STATIONARY THERMAL CONDUCTIVITY PROBLEM FOR A ROD, ON THE ENDS OF WHICH ARE ATTACHED MASSES. CALCULATION FOR A DIFFERENTIAL THERMO-BATTERY. See Abstr. 2429

2943 SURFACE ELECTROCONVECTION.
W.V.R.Malkus and G.Veronis.
Phys. of Fluids (USA), Vol. 4, No. 1, 13-23 (Jan., 1961).

An electric field can produce steady cellular motions in the interface region of two immiscible semiconducting fluids. The theory of this instability is explored. The characteristic parameter is found to depend upon the difference in conductivity of the fluids and the curvature of the interface. Quantitative finite amplitude experiments established that the electric current produced by the cellular motions is proportional to the characteristic parameter minus the critical value of this parameter.

IONIZATION

IONIZATION FRONTS IN INTERSTELLAR GAS.
See Abstr. 2596-7

INTERPLANETARY IONIZATION BY SOLAR EXTREME ULTRAVIOLET RADIATION. See Abstr. 2598

2944 MOBILITY OF HYDROGEN IONS.
R.N.Verney.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 559-60 (Dec. 15, 1960).

A short discussion of some properties of the H_3^+ ion, leading to the conclusion that it is this ion, formed in the reaction $H_2^+ + H_2 = H_3^+ + H$, which is observed in mobility measurements, rather than H_2^+ as is generally assumed. G.Carte

2945 MEASUREMENTS OF POSITIVE ION MOBILITIES OF CYCLOPROPANE AND AMMONIA IN ARGON.
D.Blanc, J.Cabé and G.Giron.
J. Phys. Radium (France), Vol. 20, Suppl. No. 7, 91A-92A (July, 1959). In French.

A Geiger counter method is used to measure mobilities of ions at low partial pressures in argon at low pressure. C.G.Morga

2946 ELECTRICAL CONDUCTIVITY OF A PARTIALLY IONIZED GAS. G.L.Cann.
Phys. of Fluids (USA), Vol. 3, No. 6, 1031-2 (Nov.-Dec., 1960).

Equations are derived for the electron and ion motion relative to the mass velocity of the gas in the energy transfer processes occurring between an electric arc and the surrounding gas. In particular the species diffusion and thermal flux in a partially ionized monatomic gas in the presence of a magnetic field is considered. The linear terms coupling the ion and electron velocities can be neglected only when the percent ionization is very low
R.Schnurmann

2947 DISSOCIATION OF H_2^+ AND He^- BY ELECTRIC FIELD
A.C.Riviere and D.R.Sweetman.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 560-2 (Dec. 15, 1960).

2 MeV, H_2^+ ions, obtained either directly from a r.f.ion source or from the dissociation of H_3^+ by gaseous collision, were dissociated to $H^0 + H^+$ and $H^+ + H^+$ by a variable strong electric field. The efficiency of the former reaction increased steadily above field strengths of 0.7×10^5 V cm^{-1} and was higher if the H_2^+ ion was derived from H_3^+, indicating the increased population of the upper vibrational states of H_2^+ when produced in this manner. The efficiency of production of $H^+ + H^+$ remained constant up to the maximum field strengths employed (5×10^5 V cm^{-1}). It was also observed that 1 MeV, He^- ions could be completely dissociated to He^0 by a field of 4.5×10^5 V cm^{-1}, but no dissociation of H^- up to the maximum field strength was noted. G.Carter

ION TRANSPORT HIGH VOLTAGE GENERATORS.
See Abstr. 2940

ELECTRIC DISCHARGES

MEASUREMENT OF TELLURIUM VAPOUR PRESSURE SING ELECTRICAL DISCHARGES. See Abstr. 2913

2948 THE TIME DEPENDENCE OF THE CURRENT IN A HYDROGEN GAS DISCHARGE. R.Kluckow.
. Phys. (Germany), Vol. 16, No. 4, 353-69 (1961). In German.

The transient growth of currents in a Townsend discharge ystem under uniform d.c.field conditions was examined. The ischarge was started by 10^3 to 10^6 electrons released from the athode by an u.v. light pulse within about 10^{-7} sec. The observed scillations of the current were found to be due to the motion of he electrons through the gap creating new electrons by photo-lectron emission at the cathode, due to photons generated in the ap. At sparking threshold conditions ($\mu_0 = 1$), the electron current ecame self-sustaining after a few electron transit times. The ositive ion current soon exceeds, the electron current and grew inearly with time ($\mu_0 = 1$) until the positive ions of the first gene-ation entered the cathode. For times greater than a positive on transit time, the current became self-sustaining. Neglecting pace-charge effects, one would not expect a spark to occur. The pace-charge of the positive ions, however, caused a distortion of he field changing the ionization efficiency of the electrons. It s shown that an observed rapid growth of current leading to break-own after some positive-ion transit times is in agreement with his concept.

2949 AN INVESTIGATION OF A HIGH-FREQUENCY DISCHARGE SUBJECTED TO HYDRODYNAMIC COMRESSION. Zh.Zheenbaev.
ptika i Spektrosk. (USSR), Vol. 9, No. 3, 288-94 (Sept., 1960). n Russian.

Describes a study of temperature characteristics of a 11.2 Mc/s ischarge in air subjected to hydrodynamic compression. Tempera-ures were studied as a function of discharge parameters. A pectroscopic analysis of iron and copper lines between 3000 and 300 A yielded discharge temperatures of about 6800°K. [English ranslation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 152-5 Sept., 1960)]. A.Tybulewicz

2950 OPTICAL AND ELECTRICAL PROPERTIES OF "STRONG" AND "WEAK" HIGH-FREQUENCY DISCHARGES IN NEON. L.P.Razumovskaya and O.P.Bochkova.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 271-3 (Aug., 1960). n Russian.

Reports a study of "strong" and "weak" forms of a 6 Mc/s ischarge in neon (external electrodes, 70 mm apart, were used). he two forms of the discharge were observed only at pressures f 0.2-0.3 mm Hg. The electron temperature was independent of he voltage across the discharge tube but was different for the two orms of the discharge: 67 000°K in the "strong" case and 81 000°K n the "weak" case. The electron density (10^9-10^{10} cm^{-3}) rose inearly with the tube voltage and was higher in "strong" discharges. Although the total luminance of the "strong" discharges was onsiderably greater than that of the "weak" ones, in both cases nly arc lines were excited. The optical differences between the strong" and "weak" discharges were related primarily to the lectron densities. [English translation in: Optics and Spectrosc. USA), Vol. 9, No. 2, 142-3 (Aug., 1960)]. A.Tybulewicz

2951 PRODUCTION OF D.C. VOLTAGE IN A LOW PRESSURE TUBE EXCITED BY A HIGH FREQUENCY ELECTRIC IELD. R.Fouret and R.Guillemard.
.R. Acad. Sci. (France), Vol. 251, No. 21, 2317-19 (Nov. 21, 1960). n French.

The production of d.c. potential and current in a low pressure elium tube (pressure 10^{-5} to 10^{-6} mm Hg) by a 48 Mc/s electric ield is described. The variation of current with position of the xciting field along the tube axis is given. The influence of the xciting voltage on current production is shown. At low pressures, he d.c. current is due to secondary emission at the electrodes. H.Edels

2952 THE DECOMPOSITION OF METHANE IN THE NEGATIVE GLOW. A.W.Tickner.
anad. J. Chem., Vol. 39, No. 1, 87-95 (Jan., 1961).

The decomposition of methane was studied in the negative glow f a d.c. discharge at pressures of 0.30 and 0.050 mm. The discharge tube was cooled by liquid or solid nitrogen. The main products were ethane, ethylene, and acetylene in addition to hydrogen and a nonvolatile product which appeared mainly on the cathode as a solid having the formula $(CH)_n$. Smaller amounts of propane, propene, propyne, butane, butene, butadiene, and pentene were also found. Lowering the temperature of the discharge tube from −196° to −210°C greatly increased the amount of ethylene recovered. The solid product is apparently transported to the cathode in the form of ions and may result from ionic polymerization of the acetylene. Acetylene is the volatile product formed closest to the cathode which suggests that it may also be formed by ionic processes. The formation of the remaining products is consistent with an excitation mechanism in which the C_2 products are formed first and the higher hydrocarbons are formed from them.

2953 STUDIES OF THE LOW PRESSURE ARGON ARC IN A MAGNETIC FIELD.
M.McChesney, P.C.McNeill and J.J.Matthews.
AEI Res. Lab. Repr. (GB), No. 392, IVA 871-IVA 815 (1960). Reprinted from The Procedings of the Fourth International Conference on Ionization Phenomena in Gases, Uppsala, 17-21 August, 1959.

The behaviour of an argon arc is examined in the pressure range 0.5 to 10 micron and in the presence of an axial magnetic field of up to 10 kG. The arc carries currents of from 2 to 40 kA and takes place in a glass tube 10 cm diameter and 80 cm long. In addition to conventional voltage and current measurements, the behaviour of the arc is examined with a Kerr cell camera, a rotating mirror camera and plate spectroscopy in the range 2000-6000 A. Discharge spectra are observed midway between the electrodes; no A I radiation is observed, the spectra being predominantly due to A II and A III with some evidence for A IV. There is relatively little strong impurity radiation. The production of such spectra are considered for two types of equilibrium and yield similar values of electron temperature to those obtained from the discharge conductivity measured after current maximum. Lack of accurate cross-section data prevents an alternative approach. The transverse velocity of the discharge column determined from the rotating mirror camera records is examined as a function of gas pressure, current and magnetic field strength. In the absence of magnetic field the velocity is found to be proportional to the average ion velocity as deduced from the Bennett relation; with applied magnetic field it is believed that electromotive forces influence the velocity.

2954 INFLUENCE OF THE CATHODE SURFACE ON ARC VELOCITY. T.J.Lewis and P.E.Secker.
J. appl. Phys. (USA), Vol. 32, No. 1, 54-64 (Jan., 1961).

An arc cathode spot in a transverse magnetic field may move either in the Amperian (forward) direction or in the opposite, i.e., retrograde sense. The rate and direction of movement are dependent on a number of parameters such as arc current, magnetic field strength, and gas pressure at the cathode root. New experiments which demonstrate clearly the effect of cathode oxide layers on arc velocity are described. A simplified model of the cathode root region of the arc which is consistent with the experimental results is proposed. The predictions of this model, which is applicable to both Amperian and retrograde motion, are also in satisfactory agreement with results obtained by previous investigators.

2955 A SPECTROSCOPIC STUDY OF DIFFUSION OF ATOMS IN AN ELECTRIC ARC.
Ya.D.Raikhbaum and V.D.Malȳkh.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 425-7 (Oct., 1960). In Russian.

Describes a method of determining the mean time that atoms spend in an arc discharge (t), based on measuring the spectral line intensities after the supply of atoms to the arc is stopped. Atoms were introduced into the arc with mobile probes. Measured values of t in a d.c. arc are given for Li, Na, Ca, Zn, Ag, Cd, and Tl; the diffusion coefficients are deduced from these values. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 223 (Oct., 1960)]. A.Tybule

2956 THE DECAY OF ARC DISCHARGES. II. PROOF OF THEORY BY EXPERIMENTAL INVESTIGATION.
G.Frind.
Z. angew. Phys. (Germany), Vol. 12, No. 11, 515-21 (Nov., 1960). In German.

For Pt I, see Abstr. 10893 of 1960. Consideration is given to the time constant of decay after arc interruption and its relationship to the arc core. Spectra and photographs of arcs in various gases

and measured time constants by other workers confirm the theory (Pt I). The double time constants observed at small currents are due to non-thermic conditions, the electron temperature giving a small time constant and the gas temperature, a large constant. Considera-tion shows that good arc quenching ability should be achieved with gases giving an arc core even when the electron density is as low as 10^{-9} cm^{-3}, e.g. F_2, Cl_2, Br_2, SF_6 and SeF_6. Calculation shows that the electron affinity has a minor influence on the time constants. H.Edels

ARC SOURCE FOR HIGH TEMPERATURE GAS STUDIES.
See Abstr. 2872

ELECTRON AND ION MOTION IN AN ELECTRIC ARC.
See Abstr. 2946

2957 THE DEVELOPMENT OF THE POSITIVE PRE-DISCHARGES IN AIR LEADING TO BREAKDOWN.
W.Hermstein.
Arch. Electrotech. (Germany), Vol. 45, No. 4, 279-88 (1960).
In German.

The main discharges considered are filament, glow and brush. When the field strength at the anode does not decrease too greatly, breakdown is always introduced by filament discharge. In the case of both homogeneous and inhomogeneous field the breakdown follows the growth of this filament. With decreasing anode curvature the voltage requirement for the filamentary discharge approaches the value associated with brush discharge. With a rapidly decreasing field at the anode, if negative ions reach the anode area a small glow is formed at the anode. The negative ions raise the field strength and limit the ionization area. Only at comparatively high voltages does this glow region become unstable and transform into a plasma channel propagating to the cathode. This plasma channel may not reach the cathode in which case one obtains a positive brush bearing close resemblance to the filament discharge. With average humidity brush discharges have a voltage requirement of 5 kV/cm. H.Edels

2958 ELECTRICAL DISCHARGES IN HYPERSONIC FLOWS.
G.Marlotte and A.Demetriades.
Phys. of Fluids (USA), Vol. 3, No. 6, 1028-9 (Nov.-Dec., 1960).

Describes experiments conducted with low-current discharges in the 5 × 5 in. test section of the Galcit hypersonic tunnel for continuous uniform flows up to M = 5.8 and total temperatures of 150° C. The breakdown voltages of air were measured between two copper or tungsten electrodes immersed in the hypersonic stream with the electric field either parallel or transverse to the stream. The results disagree with the Paschen similarity criterion and indicate that the criterion must be extended to include aerodynamic similarity. An attempt to confine an electrical discharge in the axi-symmetric wake behind a body is described and from photographs and voltage–current characteristics the wake appears to be a good confinement channel for electrical current flow. S.Weintroub

PLASMA

(See also Magnetohydrodynamics)

2959 KIRCHHOFF'S RADIATION LAW FOR PLASMAS WITH NON-MAXWELLIAN DISTRIBUTIONS.
G.Bekefi, J.L.Hirshfield and S.C.Brown.
Phys. of Fluids (USA), Vol. 4, No. 2, 173-6 (Feb., 1961).

Calculations are given for the radiation temperature in terms of the average electron energy, to be used for interpreting micro-wave radiation measurements from plasmas with non-Maxwellian distributions of electron velocities.

60 THERMALIZATION OF A FAST ION IN A PLASMA.
H.C.Kranzer.
Phys. of Fluids (USA), Vol. 4, No. 2, 214-20 (Feb., 1961).

The question of the precise rate of thermalization of a fast ion in a plasma is of some interest in connection with several existing or proposed controlled thermonuclear devices. The progress is followed of a fast ion which is injected into a plasma in equilibrium. Specially, the time history is determined of the probability distribution of this ion in velocity space. This is done by numerical integration of the linearized, space-independent Fokker–Planck equation with both the ion–ion and ion–electron interaction terms retained. The mean time of thermalization is calculated for sever widely separated injection velocities. Some other properties of th single-ion probability distribution are analysed.

2961 APPROACH TO EQUILIBRIUM OF A QUANTUM PLASMA. R.Balescu.
Phys. of Fluids (USA), Vol. 4, No. 1, 94-9 (Jan., 1961).

The treatment of irreversible processes in a classical plasm (Abstr. 3776 of 1960) is extended to a gas of charged particles obeying quantum statistics. The various contributions to the equation of evolution for the reduced one-particle Wigner function are written in a form analogous to the classical formalism. The summation is then performed in a straightforward manner. The resulting equation describes collisions between particles "dressed by their polarization clouds, exactly as in the classical situation.

2962 BINARY CORRELATIONS IN IONIZED GASES.
R.Balescu and H.S.Taylor.
Phys. of Fluids (USA), Vol. 4, No. 1, 85-93 (Jan., 1961).

An equation of evolution for the binary distribution function in classical homogeneous, non-equilibrium plasma is derived. It is shown that the asymptotic (long-time) solution of this equation is t Debye distribution, thus providing a rigorous dynamical derivatio of the equilibrium distribution. This proof is free from the funda-mental conceptual difficulties of conventional equilibrium deriva-tions. Out of equilibrium, a closed formula is obtained for the lon living correlations, in terms of the momentum distribution functio These results should form an appropriate starting point for a rigorous theory of transport phenomena in plasmas, including the effect of molecular correlations.

2963 THE SPECTRA OF SYSTEMS OF INTERACTING PARTICLES AND COLLECTIVE ENERGY LOSSES DURING THE PASSAGE OF CHARGED PARTICLES THROUGH MATTER. Yu.L.Klimontovich and V.P.Silin.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 2, 247-86 (Feb., 1960). In Russian, English translation in: Soviet Physics–Uspekhi (USA), Vol. 3, No. 1, 84-114 (July-Aug., 1960).

This review article summarizes applications of the method of the quantum distribution function to collective excitations of charg particle systems. The self-consistent field approximation is used to study plasma oscillations and zero-th sound. The effect of correlations and the Landau theory of the Fermi fluid are discuss The theory of energy losses of charged particles due to excitation of collective oscillations is developed, including the non-linear theory for the passage of intense electron beams through a plasm There is an extensive bibliography. J.Goldsto

2964 ENHANCED INTERACTION IN THE POSITIVE COLUMN. G.Ecker.
Phys. of Fluids (USA), Vol. 4, No. 1, 127-38 (Jan., 1961).

Recent theoretical work has shown that under certain conditio enhanced electron–ion interaction may be present in a plasma. T paper investigates the influence of such enhanced interaction on th characteristics of the positive column in a longitudinal magnetic field. The calculations are based on the Boltzmann transport equations, using an effective interaction parameter. Enhanced int action has several consequences. It causes enhanced diffusion anc with that an increase in electron temperature (T_-) due to increase particle wall losses. This influence on T_- is in general small and may be negligible for nonuniform enhancement. It also has a pronounced influence on the radial distribution depending on the ty of diffusion. For a given electron temperature, enhanced interacti results in an increase of the ion (T_+) — and gas (T_0) temperature due to increased energy exchange between electrons and ions. Th same effect also changes the relation $X_z(T_-)$, X_z being the longitu al electric field. Consequently, enhanced interaction influences th field X_z in two ways through the increased particle loss (T_-) and the energy exchange $X_z(T_-)$. The results suggest measurement of the radial potential distribution as a means for experimental investigation of enhanced interaction in the discharge.

2965 ELECTROMAGNETIC INTERACTION OF A BEAM O CHARGED PARTICLES WITH PLASMA.
J.Neufeld and P.H.Doyle.
Phys. Rev. (USA), Vol. 121, No. 3, 654-8 (Feb. 1, 1961).

The plasma-beam instability has been studied by Akhiezer a Fainberg (Abstr. 5920 of 1952) under the assumption that $\theta = 0$, w θ is the angle formed by the direction of the beam and the directi

f the growing wave resulting from the instability. Under these conitions the interaction is electrostatic, i.e., the wave is longitudinal. n this investigation, the above assumption is generalized so as to nclude the case of $\theta \neq 0$ and the effect of electromagnetic interaction. 'or $\omega \sim \omega_1$, where ω_1 is the Langmuir frequency of the plasma, the nteraction is electrostatic for all values of θ and the resulting in-tability which produces a longitudinal wave increases exponentially n accordance with the term $\exp(3\sqrt{3}\omega_0^2 kv_0 \cos\theta/8)^{1/3}$ (where ω_0 is he Langmuir frequency of the beam). For a frequency range below ω_1 the instability is less pronounced. However, this instability is ignificant, since the interaction is electromagnetic and the "growing wave" resulting from this interaction is characterized by an electric ector having both transverse and longitudinal components. In inestigating the above instabilities, an assumption was made that the lensity of the incident beam is small and the results cover all alues of θ except those in the immediate neighbourhood of $\pi/2$. For in the neighbourhood of $\pi/2$ the assumption is more general and he results apply to any density of the beam.

2966 MOTION OF THIN BODIES IN A HIGHLY RAREFIED PLASMA. H.Yoshihara.

Phys. of Fluids (USA), Vol. 4, No. 1, 100-4 (Jan., 1961).

Magnetic effects are considered negligible, and the velocity of he body is in a range between the electron and positive ion thermal speeds. The self-consistent field approach is used in which the electron distribution is assumed to be Maxwellian, while the positive on distribution function is given by the "collision-free" Botlzmann equation. It is assumed that the ion reflection at the body surface s specular, and the body is sufficiently thin so that the ion distribution function is a small perturbation of a Maxwellian distribution. The solution for the simple case of a dielectric body with a given urface charge, as well as some general properties to be expected or a conducting body, are given.

2967 CONFIGURATION OF A PLASMA IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. S.Katz.

Phys. of Fluids (USA), Vol. 4, No. 2, 204-9 (Feb., 1961).

Closed-form analytic solutions are obtained for the static configuration of a fully ionized low β-density adiabatic plasma immersed n an externally applied axially symmetric magnetic field. A special orthogonal curvilinear coordinate system is introduced, one of whose coordinate curves coincides with the externally applied magnetic field. By performing a perturbation expansion for a low-3 adiabatic plasma, a system of zero-order equations is obtained. Although this system of equations is incomplete, in that there are more unknowns than equations serving for their determination, a determinate integrable system of equations is obtained by specifying hat the diagonal elements of the divergence of the zero-order heat-lux tensor vanish. This system of equations is integrated to yield nalytic results dependent on the boundary conditions imposed upon he plasma. It is shown that if a trapping criterion is to be satisfied, the boundary conditions imposed upon the plasma must satisfy certain inequalities.

2968 STOPPING POWER OF HIGH TEMPERATURE PLASMA — EFFECTS OF IONIC COLLECTIVE MOTION.

Y.H.Ichikawa.

Progr. theor. Phys. (Japan), Vol. 23, No. 3, 512-18 (March, 1960).

The problem of energy loss of a charged particle travelling through a fully ionized gas is studied by taking account of effects of ionic motion. The contribution due to an ionic collective motion turns out to be smaller than that due to an electronic collective motion by order of m/M, where m is the electron mass, M the ion mass. It is shown that the ionic collective motion cannot be excited by a charged interloper unless one takes into account effects of thermal motion of the electrons.

2969 INFLUENCE OF PRE-IONIZATION ON THE EFFICACY OF A MAGNETIC COMPRESSION. EXPERIMENTAL RESULTS.

T.Consoli, R.Geller and R.Legardeur.

C.R. Acad. sci. (France), Vol. 251, No. 17, 1753-5 (Oct. 24, 1960). In French.

Deuterium plasma with electron densities between 10^{12} and 10^{14} cm^{-3} was created by a hot cathode reflex discharge in a quartz tube 100 cm long by 6 cm diameter, with a static axial field of up to 2000 G. This plasma was compressed by a 200 kc/s axial magnetic field of up to kG. Parameters of the apparatus and measuring methods together with preliminary results, particularly on the neutron yield are given. At pressures less than 10^{-3} mm Hg, the compression is without effect in the absence of the pre-ionizing discharge. R.S.Pease

2970 LEAKAGE — IN A STEADY REGIME — OF A PLASMA WITH TWO TEMPERATURES, CONFINED BY A MAGNETIC FIELD. J.M.Dolique.

C.R. Acad. Sci. (France), Vol. 251, No. 11, 1163-5 (Sept. 12, 1960). In French.

Deduces expressions for the collisional diffusion of particles across a magnetic field, for a fully ionized plasma with Maxwellian velocity distributions and unequal ion and electron temperatures. Numerical results are presented for the case of a cylindrical plasma column in a uniform axial field, with an ion temperature much less than the electron temperature. R.S.Pease

2971 PINCH WITH A SMALL ROTATION. A.Pytte.

Phys. of Fluids (USA), Vol. 3, No. 6, 1034-5 (Nov.-Dec., 1960).

Shows that a rotating pinch may be more or less stable than the corresponding stationary one, according to the rate of variation of magnetic pressure with radius. H.N.V.Temperley

2972 PINCH WITH ROTATING PLASMA. E.Gerjuoy and M.N.Rosenbluth.

Phys. of Fluids (USA), Vol. 4, No. 1, 112-22 (Jan., 1961).

The magnetohydrodynamic stability of an infinitely conducting incompressible plasma, in the shape of an infinitely long circular cylinder within an external conductor, compressed by external B_ℓ and B_z against internal B_z, is investigated in the circumstance that the plasma has an angular velocity about the z axis of the cylinder. Two different cases are examined in detail: (1) arbitrarily large constant angular velocity, in which case the differential equation for the perturbed total (magnetic plus hydrodynamic) pressure inside the plasma is solved exactly in terms of Bessel functions; (2) nonconstant but small angular velocity, in which event perturbation theory can be employed. For both these cases the rotating plasma is less stable than the nonrotating plasma.

2973 FULLY IONIZED PINCH COLLAPSE. K.Hain, G.Hain, K.V.Roberts, S.J.Roberts and W.Köppendörfer.

Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1039-50 (Dec., 1960).

A fully ionized plasma is assumed. To this plasma, cylindrically-symmetric magnetic fields are applied, thus causing a pinch collapse. The plasma is treated in hydromagnetic approximation, including electrical and thermal conductivity. Separate temperatures are assigned to the electrons and ions. Two schemes are developed for solving numerically the resulting system of six partial differential equations: the explicit scheme for rather fast pinches, where a numerical stability requirement causes the timestep to be bounded by the characteristics given by the Alfvén speed, and an implicit scheme, which consists essentially in converting the momentum equation into a second-order difference equation with coefficients determined by iteration; here there is no such restriction on the timestep. These schemes were made to work on the U.K.A.E.A. IBM 704 and IBM 709. A run is described in which the initial state was one with uniform density, temperature and B^z field. The boundary temperatures were assumed to remain constant, while the magnetic fields at the boundary were determined by the circuits for the j^z and j^Θ currents. The results of the computations are in good agreement with experimental results obtained by Köppendörfer. This investigation (which is continuing) is intended to discover by comparison with experiments how good the hydromagnetic approximations are. If the agreement is satisfactory (eventually using a generalized programme which includes neutral gas) it should be possible to design experiments so that specified field configurations are set up.

2974 INSTABILITY OF INDUCED PINCH. I.F.Kvartskhava, K.N.Kervalidze and Yu.S.Gvaladze.

Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 5, 1641-2 (May, 1960). In Russian.

A new type of instability in the so-called Θ-pinch was observed by the authors and reported previously (Abstr. 15039 of 1960). More results are now given, based on a series of pictures taken with a fast camera. The experimental conditions under which the various discharges were obtained are summarized in a table. A qualitative discussion of the experiment is given. [English translation in: Soviet Physics—JETP (USA), Vol. 11, No. 5, 1182-3 (Nov., 1960)]. G.Martelli

2975 STABLE DYNAMIC PLASMA PINCH.
V.I.Vasil'ev, V.S.Komel'kov, Yu.V.Skvortsov and S.S.Tserevitinov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 7, 756-68 (July, 1960). In Russian.

The formation and development of the pinch arising during the motion of the plasma stream in D, H and A are investigated, the initial pressures being 10^1 - 10^{-2} mm Hg. The maximum currents in the discharge attained 500 kA, the period of the current varying from 20 to 300 μsec. The current-carrying pinch is highly stable during the half-period of discharge. [Presented at the Fourth International Conference on Ionization Phenomena in Gases, Uppsala, 1959]. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 5, No. 7, 709-21 (Jan., 1961)]. F.Lachman

2976 A NEUTRON-PRODUCING MECHANISM IN TRANSVERSE PINCHES.
V.Josephson, M.H.Dazey and R.F.Wuerker.
Phys. Rev. (USA), Vol. 121, No. 3, 674-6 (Feb. 1, 1961).

Experiments performed on a transverse pinch assembly show that the presence of a longitudinal magnetic field inside of a conducting plasma and in the reverse direction to that of the external pinching field results in the generation of the m=0 (sausage) instability mechanism. This instability mechanism can generate high electrical fields which will accelerate deutrons to energies sufficient for neutron production in deuterium plasmas. Subsequent to the blowup of the instability, the plasma-field configuration is such that the accelerated deutrons can continue to circulate in stable orbits until lost by neutron-producing collisions or by diffusion out of the ends of the geometry.

2977 THE PROBLEM OF RECORDING THE ENERGY LOSSES OF A PLASMA. Yu.G.Prokhorov.
Dokl. Akad. Nauk. SSSR, Vol. 134, No. 5, 1058-60 (Oct. 11, 1960). In Russian.

Description and discussion of the performance of a device to measure the thermal insulation of a plasma contained in a torus placed in a magnetic field. A foil of platinum 6 μ thick is set on the wall of a toroidal discharge chamber and is kept incandenscent by a direct current. During the discharge, the extra energy impinging on the foil varied the power radiated by the foil in the visible spectrum, and the variation is recorded by a photomultiplier. The minimum energy flux which can be detected during a discharge is 2×10^{-3} J/cm^2, spread over periods from 0.2 μsec to several msec. [English translation in: Soviet Physics—Doklady (USA)]. G.Martelli

2978 MICROWAVE MEASUREMENTS OF THE RADIATION TEMPERATURE OF PLASMAS.
G.Bekefi and S.C.Brown.
J. appl. Phys. (USA), Vol. 32, No. 1, 25-30 (Jan., 1961).

Radiation-temperature measurements of positive columns of glow discharges in helium, neon, and hydrogen were compared with calculations and with Langmuir probe measurements of the electron temperature. The microwave-noise radiation was detected at a frequency of 3000 Mc/s. The plasma studied was illuminated by a blackbody source of known variable temperature. The blackbody temperature was adjusted until the received noise power became independent of the presence of the unknown plasma. At this point, the temperature of the two radiators is the same, irrespective of the magnitude of the plasma absorptivity.

2979 LOSS OF CHARGED PARTICLES DURING IONIZATION IN STELLARATOR DISCHARGES.
W.Stodiek, R.A.Ellis, Jr and J.G.Gorman.
Phys. of Fluids (USA), Vol. 3, No. 6, 1035-6 (Nov.-Dec., 1960).

Experimental evidence is presented in support of the suggestion that the abnormally high rate of diffusion in stellarators during the ohmic heating process also occurs during the ionization phase itself, even in the presence of a high density of neutral atoms. H.N.V.Temperley

2980 EXPERIMENTS WITH PLASMA MOVING THROUGH NEUTRAL GAS. U.V.Fahleson.
Phys. of Fluids (USA), Vol. 4, No. 1, 123-7 (Jan., 1961).

The behaviour of a rotating plasma machine was investigated. It is found that when the gas pressure and the current are varied within very wide limits the burning voltage remains constant. The voltage is proportional to the magnetic field. The reason for this behaviour seems to be the existence of a critical velocity, above which a strong interaction between a plasma and a neutral gas takes place.

2981 DEVICE FOR GENERATING A LOW TEMPERATURE HIGHLY IONIZED CESIUM PLASMA.
N.Rynn and N.D'Angelo.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1326-33 (Dec., 1960).

A device for generating a linear, highly ionized, low-temperature caesium plasma is described. The plasma is generated by having the output of caesium atomic-beam ovens impinge on hot tungsten plates placed at both ends of a cylindrical vacuum chamb The walls of the chamber are cooled so that neutral caesium condenses on them. The theory of the device, designated as the Q machine, is presented and some experimental results given. The maximum density achieved was 2×10^{12}/cm^3, with an estimated fractional ionization of 99%, and a confining field of 5900 G.

2982 NONLINEAR PHENOMENA IN A PLASMA LOCATED AN ALTERNATING ELECTROMAGNETIC FIELD.
V.L.Ginzburg and A.V.Gurevich.
Uspekhi Fiz. Nauk (USSR), Vol. 70, No. 3, 393-428 (March, 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA Vol. 3, No. 2, 175-94 (Sept.-Oct., 1960).

Reviews nonlinear wave propagation phenomena, expected and observed, particularly in ionospheric conditions. Principal effect discussed arise from the enhancement of the electron velocity, du to the electric field of the wave becoming comparable with that characterizing the velocity and collisions of the electrons in the u disturbed plasma. The absorption of strong waves can be very different from that of weak waves, and so the amplitude modulatio of a strong signal can be markedly altered by transmission throug and reflection from, a plasma. Resonant self-demodulation near electron gyrofrequency, and cross-modulation (the Luxembourg effect) are also discussed. Nonlinear effects on the phase, and th due to changes in electron density, are expected to be relatively u important. R.S.Pe

Plasma Oscillations

2983 INDUCED OSCILLATIONS IN A RAREFIED PLASMA A MAGNETIC FIELD. P.S.Greifinger.
Phys. of Fluids (USA), Vol. 4, No. 1, 104-8 (Jan., 1961).

The excitation of collective plasma motion by a small charge object moving through a low-density unbounded plasma in an external uniform, static magnetic field is considered. The energy loss per unit path length due to the excitation of collective plasma motion is found as a function of magnetic field strength for an arbitrary angle between the velocity of the object and the field direction. It is assumed throughout with that the ion temperature is zero and the velocity of the charged object is small compared to the mean thermal electron speed.

2984 STABILITY OF A SLIGHTLY INHOMOGENEOUS PLASMA. N.A.Krall and M.N.Rosenbluth.
Phys. of Fluids (USA), Vol. 4, No. 2, 163-72 (Feb., 1961).

Slightly inhomogeneous plasmas are studied to determine the stability against growing longitudinal electrostatic oscillations. T procedure is to expand Maxwell's equations and the collisionless Boltzmann equation about $\epsilon = 0$, corresponding to a uniform plasm where the expansion parameter ϵ characterizes the particle density gradient. It is found that the shift in the eigenfrequency of th oscillation is of order ϵ^2; this shift is a real number to order ϵ^2 i the eigenfrequency for the corresponding uniform plasma, $\epsilon = 0$, is a real number. Transverse modes are also examined for some special directions of propagation, with similar results. It is observed that this expansion procedure would not reproduce instabilities associated with particle drifts.

2985 LONGITUDINAL ION OSCILLATIONS IN A HOT PLASMA. R.D.Fried and R.W.Gould.
Phys. of Fluids (USA), Vol. 4, No. 1, 139-47 (Jan., 1961).

Linearized, longitudinal waves in a hot plasma include, besid the electron plasma oscillations, ion plasma oscillations with $\omega \cong \omega_p(m/M)^{1/2}$. The properties of the latter are explored using

Vlasov equation description of the plasma. For equal ion and electron temperatures, $T_e = T_i$, there exists a discrete sequence of ion oscillations, but all are strongly damped, i.e. have $-\mathrm{Im}\,\omega/\mathrm{Re}\,\omega \geq 0.5$, and hence are not likely to be observable. The ratio $\mathrm{Im}\,\omega/\mathrm{Re}\,\omega$ can be made to approach zero (facilitating detection of the waves) by either increasing T_e/T_i or by producing a current flow in the plasma. In the latter case, $\mathrm{Im}\omega$ can even be made positive (corresponding to growing waves), the current required for this being smaller the larger the value of T_e/T_i. This growing wave is just the two-stream instability which is thus seen to be an unstable ion oscillation. The ion oscillations, which for small k have the properties usually associated with an acoustic wave (longitudinal polarization, $\omega \propto k$), are obtained using a formalism which is sometimes designated as "collisionless".

2986 COUPLING MECHANISMS BETWEEN LONGITUDINAL AND TRANSVERSE WAVES IN A PLASMA.
G.Burkhardt, C.Fahl and R.W.Larenz.
Z. Phys. (Germany), Vol. 161, No. 4, 380-7 (1961). In German.

Since electron plasma oscillations are assumed to cause non-thermal cosmic r.f. radiation, the problem of coupling between longitudinal and transversal plasma waves becomes important. Starting from the basic plasma equations, all possible coupling mechanisms are deduced in a general way Besides the known mechanisms (such as the effect of a pressure gradient, of an external magnetic field, and of a general flow or drift field), a new nonlinear "internal coupling" effect which is able to generate electromagnetic radiation is proved to exist. Some remarks concerning the relativistic aspect of the problem are made.

2987 MICROWAVES IN PLASMA.
B.Agdur.
Elteknik (Sweden), Vol. 3, No. 4, 49-58 (April, 1960). In Swedish.

An ideal plasma in a steady magnetic field behaves as an isotropic dielectric and at microwave frequencies the ions can be treated as a reference lattice for the electron vibration. The quantities $N^{1/2}/\omega$ and ω_c/ω, where N is the electron density and ω_c the gyrofrequency then determine the propagation parameters. In a bounded plasma both r.f. surface and space charges affect propagation and the existence of slow waves and dispersion leads to a number of amplifier structures. H.Jefferson

REFLECTION AND TRANSMISSION OF ELECTROMAGNETIC WAVES AT ELECTRON DENSITY GRADIENTS. See Abstr. 3057

WAVE PROPAGATION IN A MOVING PLASMA. See Abstr. 3056

NONLINEAR INTERACTION OF AN ELECTROMAGNETIC WAVE WITH A PLASMA LAYER IN THE PRESENCE OF A STATIC MAGNETIC FIELD. See Abstr. 3067

ELECTRON EMISSION ELECTRON BEAMS

2988 THERMIONIC AND PHOTOELECTRIC EMISSION FROM MAGNESIUM OXIDE.
J.R.Stevenson and E.B.Hensley.
J. appl. Phys. (USA), Vol. 32, No. 2, 166-72 (Feb., 1961).

Measurements of the thermionic emission as a function of temperature and the photoelectric yield as a function of the photon energy in the range from 2.5 to 11.5 eV were made on thin films, powders, and single crystals. The thermionic emission measurements indicate that the position of the Fermi energy in most samples of MgO is controlled primarily by the electrons in a donor level located approximately 3.4 eV below the vacuum level. Measurements of the enhancement of the photoelectric yield in the impurity sensitive region gives evidence for impurity levels slightly greater than 2.4 eV and 5 eV below the bottom of the conduction band. A sharp rise in yield at 7.5 eV in active samples coincides with the optical absorption edge associated with exciton formation. Heating the samples in oxygen greatly reduces the rise at 7.5 eV but has little effect on the yield at energies greater than 10 eV. From this it is concluded that the energy difference from the top of the filled band to the vacuum level is less than 10 eV.

2989 THERMIONIC EMISSION CONSTANTS AND THEIR INTERPRETATION. E.B.Hensley.
J. appl. Phys. (USA), Vol. 32, No. 2, 301-8 (Feb., 1961).

A critical review of the procedures used in the measurement and interpretation of thermionic emission with particular reference to nonmetallic cathodes is presented. Definitions are proposed for the terms "true work function," "effective work function," and "Richardson work function." The use of Schottky plots is criticized and the advantages of effective work function plots over the conventional Richardson plots are discussed. Factors relating to the interpretation of the thermionic emission constants which are discussed include reflection coefficients, nonuniform true work functions, temperature dependence of the electron affinity, and temperature dependence of the Fermi energy.

2990 MEASUREMENT OF THE YIELD OF PHOTOELECTRONS EMITTED UNDER THE ACTION OF VERY SOFT X-RAYS. L.P.Lukirskii, M.A.Rumsh and K.A.Smirnov.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 511-15 (Oct., 1960). In Russian.

Describes a method of measuring photoelectron yields of very soft X-rays. The method is based on absolute counting of very small numbers of electrons with an electron multiplier and on absolute counting of X-ray quanta with a Geiger counter (see Abstr. 3029 of 1961). Photoelectron yields of 23-113 A X-rays were measured for Be, Ni, W, LiF, NaF, CaF_2, SrF_2 and NaCl. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 265-7 (Oct., 1960)]. A.Tybulewicz

2991 BEHAVIOUR OF PHOTOMULTIPLIERS AGAINST HIGH-FREQUENCY MODULATED LIGHT.
C.Cernigoi, I.Gabrielli and G.Iernetti.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 193-200 (Jan., 1960).

The frequency-response of several phototubes to light modulated in intensity by an ultrasonic device has been examined. Frequency of light-modulation up to 48 Mc/s was used. The method can be applied in order to select photomultipliers for fast-counting rates.

2992 SOME FACTORS AFFECTING THE GAIN AND RESOLUTION OF PHOTOMULTIPLIER TUBES.
R D.Connor and M.K.Husain.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 337-42 (March, 1960).

Changes in the gain and resolution of photomultipliers of the DuMont type are examined with reference to changes in counting rate, axial magnetic fields and temperature. While the magnitudes of these variations are found to vary as between photomultipliers, graphs are given showing typical dependences. The effects of magnetic shielding are presented and the variation of resolution with γ-ray energy in scintillation counters equipped with large NaI crystals is discussed in the light of recent statistical considerations.

2993 MULTIPLIER-PHOTOTUBE DEVELOPMENT PROGRAM AT R.C.A.-LANCASTER.
R.W.Engstrom and R.M.Matheson.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 52-7 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Symposium, Washington, February, 1960].

A development programme to provide special and improved multiplier phototubes for a variety of applications is discussed. Special emphasis is given to improving and testing multiplier phototubes for pulse-height resolution. Tubes of different sizes have been ruggedized to permit scintillation counting in unusual operating conditions, such as during rocket flight. New electron-optical arrangements in multiplier phototube structures have resulted in less transit-time dispersion. Very wide spectral response has been obtained by use of the multialkali photocathode in a fused silica envelope. Future plans include further development of very-high-speed multiplier phototubes capable of pulse rise times in the 10^{-10} sec range, and further expansion to include tubes of other sizes, tubes with lower dark current, and tubes with extended ultraviolet response.

2994 INVESTIGATION OF CATHODE UNIFORMITY AND TRANSIT TIME SPREAD OF MULTIPLIER PHOTOTUBES. S.J.Roth.
IRE Trans nuclear Sci (USA), Vol. NS-7, No. 2-3, 57-61 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The investigation of photocathode uniformity using the flying-spot

scanner technique is enhanced by the addition of a single-line-selector oscilloscope. This instrument permits a detailed study of any portion of the photocathode surface. The results obtained are of assistance in evaluating cathode uniformity as well as the efficiency of electron collection. Transit-time-spread measurements are determined by using a coincident method of detection employing output signals of opposite polarity. Measurements of transit-time spread are made by comparison with a variable light path used as a time delay.

2995 THE DEVELOPMENT OF PHOTOMULTIPLIERS FOR SCINTILLATION COUNTING.

B.R.Linden, F.W.Schenkel, Jr and P.A.Snell.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3 61-5 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The structures and characteristics of a new range of photomultipliers is described. Some recent results on the investigation of pulse-height shift are presented. The development of photomultiplier tubes for the detection of low-level radioactivity is discussed. This involves using tube materials with a minimum of radioactive contamination for such applications as whole-body counting. For low-energy nuclear radiation detection (e.g. detection of tritium) a tube has been developed which eliminates thermionic emission from the unused portions of the cathode which have been deposited on the sidewalls of the tube.

2996 NEW RUGGED HIGH-TEMPERATURE PHOTOMULTIPLIERS. J.P.Causse.
IRE Trans nuclear Sci.(USA), Vol. NS-7, No. 2-3, 66-71 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A new photomultiplier has been designed which, up to temperatures of 150°C, is suitable for scintillation counting of the natural radioactivity of sediments traversed by an oil well. It uses a special head-on photocathode which is a compromise of stability, sensitivity and noise. The tube envelope is made of a succession of parallel Kovar and glass rings fused together. Venetian-blind dynodes of the Lallemand type are welded to the inner side of the Kovar rings and bleeder resistors to the outer side. This structure combines excellent mechanical properties (ruggedness, freedom from microphony) with the very high electrical insulation needed, even at elevated temperatures. Taking advantage of the great versatility of the multiplier structure, several other types of tube were built with conventional photocathodes (S-11 and S-17) and 14 and 18 stages. They are intended for applications requiring good performance associated with ruggedness.

2997 PHOTOTUBES CAPABLE OF HIGH CURRENT OUTPUT. S.F.Essig.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 71-3 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Describes a series of phototubes which have large dynamic range and are capable of high current output. The tubes, in conjunction with a solid scintillator, have become largely standard for measurement of high-intensity, short-duration, gamma radiation. Electrical and optical characteristics are given and discussed.

2998 DARK CURRENT IN PHOTOMULTIPLIERS. J.A.Baicker.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 74-80 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A study was undertaken to determine the nature of the processes that contribute to dark current in photomultipliers. Extensive measurements were made on a number of production-type photomultipliers and on a series of experimental tubes that were designed to minimize leakage and regeneration. Variations in the dark current, pulse-height distribution and counting rate with applied voltage, cathode temperature, and residual gas pressure were measured. The experimental method and preliminary results are discussed.

2999 RESPONSE OF END-WINDOW PHOTOMULTIPLIER TUBES AS A FUNCTION OF TEMPERATURE.

R.B.Murray and J.J.Manning.
IRE Trans. nuclear Sci. (USA), Vol. NS-7, No. 2-3 80-6 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A study of the response of commercial end-window photomultipliers to light of various wavelengths (4000 to 7000 A) as a function of temperature. All tubes studied were of nominal 2-in. diameter, and included various standard tubes made by DuMont and R.C.A., low-temperature modifications of standard tubes, and multi alkali-photocathode tubes. Most of the experiments were performed with the tube operating as a multiplier; in a series of auxiliary experiments, the dynode string was shorted to the anode so that the effect of cooling the cathode could be studied separately. In a typical tube the response to blue light increases somewhat with decreasing temperature, whereas the response to red light decreases rapidly; these effects are associated with changes in the photocathode spectral sensitivity. At low temperatures (about −100°C or below) the response falls sharply for all wavelengths, an effect attributed to the increased resistivity of the semiconducting photocathode. This effect is not observed in tubes whose photocathode is covered with a semitransparent metallic backing. The temperature dependence of spectral sensitivity in multialkali-photocathodes (R.C.A. C-7261) is significantly different from that of Cs–Sb photocathodes.

3000 WORK AT IMPERIAL COLLEGE [LONDON] ON IMAGE INTENSIFIERS WITH TRANSMITTED SECONDARY ELECTRON MULTIPLICATION.

W.L.Wilcock, D.L.Emberson and B.Weekley.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 126-32 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The construction and properties of some magnetically-focused image intensifiers incorporating potassium chloride films as transmitted secondary-electron multiplying dynodes is described. Tubes were prepared with five dynodes which give a total electron multiplication of the order of 3000. Single electrons leaving the cathode of these tubes give rise to scintillations at the output phosphor with diameters of about 40 μ, which are bright enough to be photographed.

3001 THE TRANSMISSION SECONDARY EMISSION IMAGE INTENSIFIER AND ITS APPLICATION TO LOW LIGHT LEVEL IMAGING. A.E.Anderson.
IRE Trans nuclear sci. (USA), Vol. NS-7, No. 2-3, 133-6 (July-Sept. 1960). [Proceedings of the Seventh Scintillation Counter Symposium Washington, February, 1960].

Performance data on recent 4-stage intensifier tubes having 1 in. useful diameter is given. At low light levels, viewing with these tubes is photoelectron-noise-limited. These tubes resolve a minimum of 12 line pairs/mm or a total of 300 line pairs across a diameter. Photon gains as high as 20 000 have been measured. Application of this intensifier to nuclear track photography is described.

3002 PRESENT STATUS OF THE CHANNELED IMAGE INTENSIFIER. J.Burns and M.J.Neumann.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 142-4 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The channelled electron multiplier in a form suitable for scintillation track imaging is described briefly. The present state of its development is outlined together with performance data on gain, background, resolution, etc. Future developments and performance capabilities are discussed.

3003 INFLUENCE OF SURFACE CHARGE ON THE PHOTOELECTRIC EMISSION FROM INSULATORS IN THE IMAGE CONVERTER. P.Hartmann.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1747-9 (Oct. 24, 1960). In French.

When insulators are used as photocathodes in image converter tubes, it is found that the image becomes distorted and the photoemission diminishes with increasing time. These effects may be explained by a consideration of the perturbing effect of positive charges on the photocathode on the electron optics of the tube. A detailed investigation of the temporal changes in the image of a mercury ultraviolet spectrum using a fused silica photocathode is described. C.H.B.Me

3004 CONTRIBUTIONS AND DISCUSSIONS AT THE COLLOQUIUM ON IMAGE CONVERTORS AND IMAGE STORAGE TUBES.
SB Heidelberg. Akad. Wiss. (math.-nat. K1) (Germany) 1959, No. 5, 78 pp. In German.

Proceedings of a meeting held in Heidelberg, on 28-29 April 1958. Seven papers were presented, abstracts of which will appear (under the appropriate headings) in this or succeeding issues of "Science Abstracts".

3005 ENERGY DISSIPATION AND SECONDARY ELECTRON EMISSION IN SOLIDS. H.Kanter.
Phys. Rev. (USA), Vol. 121, No. 3, 677-81 (Feb. 1, 1961).

Experimental evidence is presented for the proportionality between secondary electron yield and the energy dissipated by electrons near the surface of a solid. Using measurements of the energy carried away by electrons transmitted and reflected from thin foils of aluminium and carbon, the energy dissipated in an incremental layer at the exit surface was obtained. Simultaneous measurements of the secondary electron yield showed a close proportionality between the number of secondaries produced and the energy dissipation density near the surface independent of the incident electron energy between 1 and 10 keV. By subtracting the contribution of the backscattered electrons to the yield at the front surface of a thick aluminium target, the yield of secondaries was found to be proportional to the rate of energy loss calculated from the Bohr–Bethe theory over the energy range investigated.

3006 CONTRIBUTION OF BACKSCATTERED ELECTRONS TO SECONDARY ELECTRON FORMATION. H.Kanter.
Phys. Rev. (USA), Vol. 121, No. 3, 681-4 (Feb. 1, 1961).

It is shown experimentally that backscattered electrons emitted from solids under electron bombardment contribute significantly to the observed secondary yield, even for the case of low backscattering coefficients. Thus, it was found that in Al with a backscattering coefficient of only 0.14, about 40% of all secondaries are produced by backscattered electrons for initial energies from several keV to several tens of keV. The large contribution of backscattered electrons to secondary formation even for materials of low atomic number agrees approximately with what one would expect from the larger rate of energy loss and the greater path lengths of the backscattered electrons in the secondary electron escape region compared to that of the incoming primaries.

3007 SPACE CHARGE INSTABILITIES IN SYNTHESIZED PLASMAS. A.L.Eichenbaum and K.G.Hernqvist.
J. appl. Phys. (USA), Vol. 32, No. 1, 16-21 (Jan., 1961).

A theoretical and experimental investigation of instability phenomena in synthesized plasmas is carried out. In the theoretical analysis the space charge and potential distributions are obtained for an idealized one-dimensional model. The model consists of two face-to-face electrodes each emitting ions and electrons in any ratio and with a Maxwellian velocity distribution. The calculations show that no stable zero-field solution is possible; instead, distributions with either a potential maximum or minimum in the centre are obtained. For a range of values of the ratio β of injected ion to electron space-charge density near unity ($0.81 \leq \beta \leq 1.235$), double-valued solutions to the problem are obtained. The actual solution into which the system settles depends on whether this range of β values is approached from above or below. Transitions from one such state to the other can occur at the limits of this β range. In the experimental investigation of a synthesized plasma, these instabilities, or state-to-state transitions, were found to be in good agreement with the theory. Oscillations triggered by state-to-state transitions were observed with a frequency corresponding to the ion transit time through the interelectrode space. These oscillations are not described by the steady-state analysis.

3008 VELOCITY MODULATION AND RELATED HIGH FREQUENCY DEFLECTION ERRORS OF THE TRAVELING WAVE DEFLECTION SYSTEM. J.Goldberg.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1320-5 (Dec., 1960).

The potential and electric field distributions in a travelling-wave deflection system are derived for a sinusoidal deflecting signal. They are then generalized for application to arbitrary deflecting signals. It is shown that a longitudinal field exists and depends on the odd derivatives of the signal. This component of the field modulates the velocity of the beam and gives rise to errors in focusing and time axis position. The velocity modulated beam is then dispersed by the time axis deflection system. The nonuniformity which much exist in the deflecting component of the field is shown to depend on the even derivatives of the deflecting signal. The nonuniformity gives rise to dispersion and errors in deflection of the beam by the travelling-wave deflection system. Generalized expressions for these errors are derived, and the errors are evaluated for a representative set of conditions.

3009 TRANSVERSE ELECTRON BEAM WAVES IN VARYING MAGNETIC FIELDS. E.I.Gordon.
Bell Syst. tech. J. (USA), Vol. 39, No. 6, 1603-16 (Nov., 1960).

The properties of electron cyclotron and synchronous waves in varying magnetic fields are discussed. Magnetic field variations in space and time are considered. The problem is treated by establishing the wave excitation from knowledge of the macroscopic beam motion. It is shown that the cyclotron wave is coupled to the synchronous wave and that both waves are always amplified in a changing field. Unless the charge density is an appreciable fraction of the full Brillouin value, however, the individual electron orbits will be amplified along with the waves causing beam expansion. The phase velocity of the waves is shown to be approximately independent of space charge. In the case of a spatially varying field, one of the waves must be fast, carrying positive kinetic power, and the other slow, carrying negative kinetic power. The total kinetic power carried by the two waves is conserved. When the magnetic field varies in time, the kinetic power of the two waves is not conserved but the Manley-Rowe relation is satisfied. When the field varies at a rate greater than the signal frequency, both modes may carry positive kinetic power.

3010 NOISE PROPAGATION IN DRIFTING MULTIVELOCITY ELECTRON BEAMS. J.A.Morrison.
J. appl. Phys. (USA), Vol. 31, No. 11, 2066-7 (Nov., 1960).

A criticism of the work of Berghammer and Bloom (Abstr. 19739 of 1960). The approximate macroscopic analysis of these authors gives results for the noise parameters S and Π, and therefore for the minimum noise figure, which disagree with computer calculations using the analysis of Siegman (Abstr. 7080 of 1958). The assumption that the velocity spread is small implies that only two normal modes require to be included and these cannot satisfy the input conditions. A.H.W.Beck

3011 COUPLED MODE THEORY OF ELECTRON-BEAM PARAMETRIC AMPLIFICATION.
R.W.Gould and C.C.Johnson.
J. appl. Phys. (USA), Vol. 32, No. 2, 248-58 (Feb., 1961).

A theory of parametric amplification in a filamentary electron beam by transverse fields is developed in coupled mode form. Space charge effects are neglected. In addition to beam modes at the signal frequency, beam modes at frequencies $\omega_n = \omega + \omega_p$, $n = 0, \pm1, \pm2 \ldots$, where ω_p is the pump frequency, are coupled together. A discussion of the general form of the equations is given and reveals the circumstances under which exponential gain or periodic energy transfer between various modes can occur. When applied to quadrupole electric pump fields, a description of the quadrupole amplifiers of Adler et al. (1959) and Gordon (1960) is obtained. This theory is then used to evaluate the noise contribution from synchronous beam modes and higher cyclotron idler modes. Coupling by axially symmetric electric fields and by axially symmetric magnetic fields is discussed, and other amplification schemes suggested. The theory of coupling by axially symmetric fields can also be used to study lens effects on noise in the gun region.

3012 EXPERIMENTAL STUDY OF ANOMALOUS ELECTRON STREAM BEHAVIOR. M.H.Miller and W.G.Dow.
J. appl. Phys. (USA), Vol. 32, No. 2, 274-81 (Feb., 1961).

Experimental measurements on the characteristics of the sole current in a rectilinear crossed-field beam are reported. The sole current may be assigned a kinetic temperature on the order of 10 V corresponding to energy in excess of that corresponding to motion in static fields. The energy exchange leading to this excess energy is believed to be associated with multiple-loop trajectories in the low-potential region near the cathode.

ELECTRON STREAM INTERACTION WITH BACKWARD WAVES PROPAGATING ON FERRITE RODS. See Abstr. 3065

3013 EXTENSION OF GANS'S METHOD TO THE CALCULATION OF ELECTRON TRAJECTORIES IN CROSSED FIELDS. R.Vauthier and J.Chantreau.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1744-6 (Oct. 24, 1960). In French.

A method is given for calculating the trajectories of charged particles in crossed electrostatic and magnetic fields by approximating the path to a succession of arcs. The magnetic induction is assumed to be uniform and the result is in the Gaussian approxi-

mation. Another communication will give the application of the method to the calculation of ion trajectories in a Nier type of source for mass spectrometry. V.E.Cosslett

3014 CORRECTION OF THE SPHERICAL ABERRATION OF ELECTROSTATIC QUADRUPOLE LENSES FUNCTIONING ASTIGMATICALLY. A.Septier and J.van Acker.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1750-2 (Oct. 24, 1960). In French.

Three methods are proposed for correcting the effect of spherical aberration on the focal lines formed by a quadrupole lens (or a doublet): by introducing a degree of asymmetry in the applied potential, by slight modification of the electrode form, or by adding an octupole lens to the system. V.E.Cosslett

3015 FIRST-ORDER STUDY OF AN OPTICAL SYSTEM CONSISTING OF FOUR ELECTROSTATIC QUADRUPOLE LENSES. D.Dhuicq.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 1989-91 (Nov. 7, 1960). In French.

An experimental study has been made of the optical properties of a system of four quadrupoles, arranged symmetrically and acting as a projector. The results are compared with calculations made by a method previously described (Abstr. 3806 of 1960). The lack of close agreement is ascribed to the use of a simple rectangular model for the shape of the field, as well as to experimental error. There exists only one set of conditions in which the system is stigmatic, and the focus is then immersed in the lens. V.E.Cosslett

3016 ELECTRON INTERFERENCE AT SEVERAL ARTIFICIALLY-PRODUCED FINE SLITS. C.Jönsson.
Z. Phys. (Germany), Vol. 161, No. 4, 454-74 (1961). In German.

A glass plate covered with an evaporated silver film of about 200 A thickness is irradiated by a line-shaped electron-probe in a vacuum of 10^{-4} torr. A hydrocarbon polymerization film of very low electrical conductivity is formed at the places subjected to high electron current density. An electrolytically deposited copper film leaves these places free from copper. When the copper film is stripped a grating with slits free of any material is obtained. Slits 50 μ long and 0.3 μ wide with a grating constant of 1 μ are obtained. The maximum number of slits is five. The electron diffraction pattern obtained using these slits in an arrangement analogous to Young's light optical interference experiment in the Fraunhofer plane and Fresnel region shows an effect corresponding to the well-known interference phenomena in light optics.

3017 ANTIPARALLEL WEISS DOMAINS AS BIPRISMS FOR ELECTRON INTERFERENCE.
H.Boersch, H.Hamisch, D.Wohlleben and K.Grohmann.
Z. Phys. (Germany), Vol. 159, No. 4, 397-404 (1960). In German.

Fast electrons passing through thin ferromagnetic films are deflected by the Lorentz force, through an angle proportional to the film thickness and the flux density in the plane of the film. On either side of the boundary between two Weiss domains, magnetized in opposite senses, the deflections are in opposite directions and the emergent beams can overlap in such a way as to give two-beam interference, as with the Fresnel mirror experiment in optics. The theoretical conditions for observing the resultant fringes are derived, including the number and separation of the fringes. Their intensity in the final image plane depends only on the magnetic deflection, the number of fringes and the thickness of the transitional region between domains (Bloch wall), at given accelerating potential. The experimental conditions were calculated for observing a given number of fringes (5) in an electrostatic lens system arranged first as a shadow microscope and then as a normal electron microscope, but defocused. The number and separation of the fringes observed agreed with theory within the limits of error, which were not narrow enough to allow the thickness of the Bloch wall to be deduced, as hoped. Reasons for the deflection being appreciably less than expected are discussed, as also is the bearing of this work on the Ehrenberg–Sturrock–Bohm experiment (Abstr. 12997 of 1959). The present results support the idea that the magnetic vector potential exerts a direct physical effect on the electron beam. However, they involve passage of the electron beam through a magnetic field, whereas the experiment discussed by Aharonov and Bohm requires the electrons to pass outside the magnetic field. V.E.Cosslett

3018 A RETARDING FIELD METHOD OF MEASURING THE ENERGY AND ANGULAR DISTRIBUTION OF SCATTERED ELECTRONS. M.Horstmann and G.Meyer.
Z.Phys. (Germany), Vol. 159, No. 5, 563-83 (1960). In German.

A retarding field apparatus is described, by means of which i elastically scattered electrons can be separated from the elastically scattered component. It was used to measure the energy distribution of electrons in diffraction patterns, some results of which were described earlier (Abstr. 8917 of 1959). It can also be used to filter out all electrons which have lost more than a given amount of energy (down to a limit of 2eV) throughout the angular spread of an electron diffraction pattern, i.e. to eliminate the background. The design and construction of the apparatus is described in detail, special attention being paid to the d.c. amplifier and the stabilization conditions. At present the sensitivity of the method i limited by the noise level of the d.c. amplifier. Even so, the accuracy in measuring the intensity of strong diffraction rings (2% is greater than that of either the photographic or the counter meth of recording. V.E.Cossle

ION EMISSION . ION BEAMS

3019 EFFECT OF ELECTRIC FIELDS ON THE TEMPERATURE THRESHOLD OF THE APPEARANCE OF POSITIVE IONS DURING SURFACE IONIZATION OF ATOMS.
É.Ya.Zandberg.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 6, 629-34 (1960). In Russian.

"Cathode electronics Conference" Moscow, 1959 (see Abstr. 17022 of 1960). Analysis of ionization at temperatures up to about 1000^0K in the presence of electric fields (which draw off the ions) gave a formula

$$(l_+ - \epsilon\sqrt{\epsilon E} + \epsilon E x_{cr})/kT = \text{const.},$$

where l_+ is the isothermal heat of evaporation of the ion, ϵ is the ion charge, E is the electric potential and x_{cr} is the critical distance of overcharging of the adsorbed atom near the surface. In the case of fields for which the third term in brackets can be disregarded, the relationship between T and $\sqrt{E}$ becomes linear. Experiments carried out with a beam of CsCl molecules and Katom by the method described in an earlier paper (Abstr. 10873 of 1960) bore out the above formula. F.Lachma

3020 ON THE POSSIBILITIES OF LOCAL ANALYSIS OF A SPECIMEN USING ITS SECONDARY ION EMISSION.
R.Castaing, B.Jouffrey and G.Slodzian.
C.R. Acad. Sci. (France), Vol. 251, No. 8, 1010-12 (Aug. 22, 1960). In French.

The positive ion bombardment of clean metallic surfaces gives rise not only to secondary electrons but also secondary positive ions. The latter are characteristic of the region bombarded and hence can be used for analytical purposes. The primary ion beam (4 keV) must be of high density and located well away from the target. Outlines of a suitable apparatus are given together with methods of isolating the secondary ion beam, which is then analysed by mass spectrometry. Si, Al and Mg give intense secondary ion emission, Be, Cu and Ni slightly less. Preliminary results seem most promising. R.Ree

3021 CONCERNING A PROTON SOURCE WITH MULTIPLE BEAMS. G.Olive.
C.R. Acad. Sci. (France), Vol. 251, No. 15, 1474-6 (Oct. 10, 1960). In French.

The r.f. source described by Allison and Norbeck (Abstr. 5162 of 1956) was modified by using several extraction orifices instead of one. Beam currents extracted at 1500 V are given for various orifice arrangements, using 150 W r.f. power. The maxim total beam current quoted is 12.2 mA, for seven orifices. R.S.Peas

3022 ON THE OPTIMUM WORKING PRESSURE OF HIGH FREQUENCY SOURCES GIVING POSITIVE ARGON IONS. ROLES OF EXTRACTION POTENTIAL, OSCILLATOR POWER AND FREQUENCY. D.Blanc and A.Degeilh.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 2009-11 (Nov. 7, 1960). In French.

Continues earlier work (Abstr. 7911 of 1959; 15085 of 1960).

Shows that for the particular ion source used, with a 1 mm diaphragm, the optimum working pressure is independent of extraction potential and oscillator power and frequency. Above the optimum pressure, Bohm's theoretical relationship between current and source pressure is confirmed: $I = Kp^{-1/2}$. [D. Bohm. The characteristics of electrical discharges in magnetic fields. Chapter 3. New York: McGraw-Hill (1949)]. J.W.Sturgess

3023 MASS SPECTROMETER FOR THE ISOTOPIC ANALYSIS OF LITHIUM. R.G.Ridley and D.E.P.Silver.
J. sci. Instrum. (GB), Vol. 38, No. 2, 47-51 (Feb., 1961).

A mass spectrometer has been designed for the routine analysis of lithium. Microgram samples of lithium nitrate are ionized in a thermal ionization source. A 60^0 sector magnet analyses the two ion beams which are collected simultaneously on two separate collectors. The source is pulsed and the two signals are a.c. amplified and then subtracted from one another. The difference is displayed on a cathode-ray tube and the ratio is given rapidly by reading attenuation dials after adjusting for a null deflection. A calibration technique corrects for unequal transmission through the spectrometer and for inequalities in the circuitry. The precision of a single measurement of isotope ratio is ±0.7%.

3024 ION-OPTICAL IMAGING WITH RADIOACTIVE RECOIL PARTICLES. I. S.Stühmer.
Nukleonik (Germany), Vol. 2, No. 1, 1-7 (Jan., 1960). In German.

Describes a 60 kV ion-emission electron microscope suitable for for forming enlarged images (50 to 200 ×) of an emitting surface using either positive or negative ions at will. A further development of the technique is to lay down a radioactive coating on the specimen and to use the low-energy recoil particles to form the image. Examples of this form of radiography are given.
A.E.I. Research Laboratory

3025 ION-OPTICAL IMAGING WITH RADIOACTIVE RECOIL PARTICLES. II. H.A.Willax.
Nukleonik (Germany), Vol. 2, No. 1, 7-20 (Jan., 1960). In German.

For Pt I see preceding abstract. The total yield of the recoil particles during the Th B to Th C β-decay in the active layer was measured with a view to determining the physical conditions that exist when imaging a surface with such particles. It was found that the existence of positively- and negatively-charged Th B and Th C atoms makes this type of imaging possible. The yield of such particles depends strongly on the material onto which the active material is deposited and on the method of preparation.
A.E.I. Research Laboratory

THE ELECTROMAGNETIC ISOTOPE SEPARATOR IN PRETORIA. See Abstr. 2303-4

3026 SPUTTERING OF VITREOUS SILICA BY 20 TO 60 keV Xe^+ IONS. R.L.Hines and R.Wallor.
J. appl. Phys. (USA), Vol. 32, No. 2, 202-4 (Feb., 1961).

Experimental values for the sputtering of quartz by xenon positive ions at flux densities of 2×10^{15} ions cm^{-2} sec^{-1} in a vacuum of 10^{-5} mm Hg were found by measuring the volume of the sputtered cavity by means of interference fringe contours. The sputtering ratios are 0.706 ± 0.061 at 20 keV, 0.85 ± 0.13 at 30 keV, 1.78 ± 0.13 at 40 keV, 1.74 ± 0.12 at 50 keV, and 1.31 ± 0.09 at 60 keV. The technique of volume measurement by interference fringe contours has an accuracy of $\pm 2 \times 10^{-8}$ cm^3 and is estimated to have an ultimate accuracy of $\pm 10^{-10}$ cm^3.

PARTICLE ACCELERATORS

ION TRANSPORT HIGH VOLTAGE GENERATORS. See Abstr. 2940

3027 BEAM STABILITY OF A 20 MeV BETATRON. D.Greene.
Brit. J. Radiol., Vol. 34, 129-32 (Feb., 1961).

It has been shown that the X-ray beam from a betatron moves continuously with respect to the magnet. The rate of movement is small, but is sufficient to raise significant dosimetric problems. It is thought that the effect is associated with thermal expansion of the magnet. A servomechanism which keeps the collimator and flattening filter centred on the beam is described.

3028 MEASUREMENT OF BETATRON OSCILLATION FREQUENCIES IN THE COSMOTRON. M.Q.Barton.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1290-1 (Dec., 1960).

Coherent betatron oscillations are excited by an impulse magnetic field in one straight section of the cosmotron. The resulting oscillations can be observed using a communications receiver connected to the radial position induction electrodes.

FIELDS IN GAP-EXCITED CIRCULAR DUCTS. See Abstr. 1974

X-RAY TUBES AND TECHNIQUES

3029 A MONOCHROMATOR FOR VERY SOFT X-RAYS WHICH CAN COUNT THE ABSOLUTE NUMBER OF QUANTA. A.P.Lukirskii, M.A.Rumsh and L.A.Smirnov.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 505-10 (Oct., 1960). In Russian.

Describes a vacuum X-ray monochromator with a diffraction grating for use at wavelengths between 15 and 120 A. Methods of adjustment are given, as well as techniques of production and stabilization of monochromatic radiation. The absolute number of X-ray quanta can be counted with a Geiger counter. [English translation in: Optics and Spectrosc.(USA), Vol. 9, No. 4, 262-5 (Oct., 1960)]. A.Tybulewicz

3030 PRODUCTION OF MONOCHROMATIC X-RADIATION OF DESIRED FREQUENCY FROM THE CONTINUOUS SPECTRUM. H.Kudielka and H.Möller.
Z. angew. Phys. (Germany), Vol. 12, No. 10, 476-80 (Oct., 1960). In German.

Describes the application of a bent quartz crystal monochromator to select a narrow frequency band from the continuous spectrum of a conventional X-ray tube. Applications of this method to X-ray diffraction are described. A possible disadvantage is the presence of second- and third-order reflections which also appear at the output slit of the monochromator.
A.E.I. Research Laborator

3031 EXPERIMENTAL EVIDENCE FOR DOUBLE REFRACTION OF X-RAYS. A.Authier.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 2003-5 (Nov. 7, 1960). In French.

The effect is shown by passing a very finely collimated beam through a silicon crystal and photographing the four beams that issue from it. A.R.Stokes

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

3032 THE ACCURACY OF HALL ELEMENTS. L.S.Vasil'chenko, L.V.Sentyurina and B.S.Sotskov.
Avtomat i Telemekh. (USSR), Vol. 20, No. 7, 939-45 (1959). In Russian. English translation in: Automat. remote Control (USA), Vol. 20, No. 7, 913-20 (July, 1959; publ. March, 1960).

The use of the Hall effect in semiconductors (particularly InSb and Ge) for measuring magnetic field strengths is discussed. The sensitivities of such devices, and the various sources of error are analysed in detail. S.A.Ahern

3033 DEMAGNETIZING FUNCTIONS FOR CYLINDRICAL RODS. S.Haraldson and B.Myrgren.
Ericsson Tech. (Sweden), Vol. 15, No. 2, 285-315 (1959).

In a plane passing through the centre and normal to the axis of a magnetized cylindrical iron rod the magnetic field strength is constant inside, and a simple logarithmic function of the distance from the rod axis outside the rod. It is possible to measure the field strength at the surface using three coils, concentric with the rod. Using this method with an integrator and an X–Y recorder it is possible to obtain the magnetization curve for a straight cylindrical rod. The rod should be long compared with its diameter, but it is not necessary to know its exact length.

3034 MAGNETIC SUSCEPTIBILITY MEASUREMENTS OF SINGLE SMALL PARTICLES.
S.J.Gill, C.P.Malone and M.Downing.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1299-1303 (Dec., 1960).

A method for measuring the diamagnetic or paramagnetic susceptibilities of small particles of diameters of 1 to 100 μ is described. Theoretical considerations are given for the design of the apparatus and for the interpretation of measurements. Susceptibility determinations of polystyrene latexes and red blood cells show the use of the method.

3035 MEASUREMENT OF MAGNETIC SUSCEPTIBILITY IN VERY HIGH PULSED FIELDS. R.Stevenson.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 28-31 (Jan., 1961).

A technique is described for making Gouy-type measurements of magnetic susceptibility in high transient magnetic fields. The magnetic force on the sample travels as a stress wave through the apparatus assembly and excites a voltage on two piezoelectric crystals which are the active elements of the transducer. The apparatus has a small risetime and high response. Typical experimental difficulties are described.

3036 STRONG MAGNETIC FIELDS.
G.M.Strakhovski and N.V.Kravtsov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 4, 693-714 (April, 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 2, 260-72 (Sept.-Oct., 1960).

A strong magnetic field is defined as one whose intensity exceeds 20 or 30 kOe. The problems of mechanical design of suitable coils are discussed and graphs are given of the various design parameters. Some details are given of apparatus for field intensities up to 1600 kOe and an extensive list of references is included. V.G.Welsby

3037 PRODUCTION OF MAGNETIC FIELDS EXCEEDING 15 KILOGAUSS BY A SUPERCONDUCTING SOLENOID.
J.E.Kunzler, E.Buehler, F.S.L.Hsu, B.T.Matthias and C.Wahl.
J. appl. Phys. (USA), Vol. 32, No. 2, 325-6 (Feb., 1961).

A solenoid, made from 0.007 cm diameter gold-plated Mo_3Re wire, using 30 000 turns on a 3 cm long former with a 0.3 cm core, remains superconducting at 1.5^0K with fields up to about 15 kG along the central 1 cm. Some further information is provided about the preparation of the wire, the coil and the critical fields of the material. L.Mackinnon

3038 APPARATUS DRAWINGS PROJECT: REPORT NUMBER 13. LARGE ELECTROMAGNET. R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 2, 86-9 (Feb., 1961).

Describes a simple low-cost electromagnet, of relatively large size, that can be constructed in a small shop with minimal machine tools. The cross-sectional area of the hot-rolled steel core is 4×4 in. The pole faces can be set to give gap widths ranging from 0 to 14 cm. With a gap width of 0.5 cm and a coil current of 4.5 A, the field produced exceeds 2 weber/m^2. Construction details are given.

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

THE CLASSICAL FIELD THEORY OF MATTER AND ELECTRICITY. See Abstr. 2679-80

3039 ANALYTICAL FOUNDATIONS OF THE THEORY OF THE ELECTROMAGNETIC FIELD. G.Zin.
Atti Accad. Sci. Torino I (Italy), Vol. 94, No. 6a, 719-25 (1959-60). In Italian.

See Abstr. 3260 of 1958.

3040 MOVEMENTS OF ELECTROMAGNETIC FIELDS. R.Codelupi.
Elettrotecnica (Italy), Vol. 46, No. 2, 66-71 (Feb. 15, 1959). In Italian.

Given a varying electric field, it is possible to define a velocity field corresponding to the rate of deformation of the lines of force. The magnetic field can be treated in the same way. The two velocities thus obtained can be related to the energy flow represented by the Poynting vector. V.G.Wels

3041 ON THE LORENTZ CONDITION. P.Poincelot.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 1986-8 (Nov. 7, 1960). In French.

A note on the relation between the electric potential and the magnetic vector potential in a conducting medium, when relativist effects are negligible. J.Hawg

3042 ENERGY LOSS AND RADIATION OF A GYRATING CHARGED PARTICLE IN A MAGNETIC FIELD — NON-IONIZED MEDIUM. K.Kitao.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 759-75 (May, 1960).

Fourier series expansions are used to obtain the expressions for the components of the electromagnetic field at an arbitrary po of observation and for the total energy loss of a gyrating charged particle in a non-ionized medium having a uniform magnetic field. For a non-relativistic particle, it is shown that the total energy lo is split into the collision loss, for which formula is found to be the familiar one for linear motion, and the loss due to cyclotron radiations. The relative magnitude of the latter to the former is less than $(\omega_2/\omega_p)^2$, where ω_0 is the cyclotron frequency and $\omega_p^2 = 4\pi n_e e^2/m_e$ where n_e and m_e are the density and mass of electrons in the medium. In the relativistic case, one obtains the explicit formula of the polarization loss, depending upon the exter magnetic field, and of the losses due to the Cherenkov and synchro tron radiations. The spectral and angular distributions of these tw radiations are discussed.

3043 TWO-DIMENSIONAL PROBLEM OF AN INCOMPRESSIBLE FLUID OF FINITE [ELECTRICAL CONDUCTIVITY FLOWING PAST SOLID BODIES IN THE PRESE OF A MAGNETIC FIELD PERPENDICULAR TO THE FLOW.
K.A.Lur'e.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 9, 1035-40 (Sept., 1960). In Russian.

An insulating parabolic cylinder is standing in a fluid which is flowing symmetrically against its vertex. A segment near the vertex is separated from the bulk of the cylinder by a vertical pla where conducting sheets allow an electric current to surround the segment thus inducing there a vertical magnetic field. By the way of an extensive deduction, an expression is obtained expressing th magnetic field strength as a function of the coordinates at large distances from the vertex. [English translation in: Soviet Physics Technical Physics (USA), Vol. 5, No. 9, 966-72 (March, 1961)]. R.Eisensch

3044 THE SETTING IN MOTION AND STOPPING OF A CONDUCTING LIQUID IN A ROTATING CYLINDRICA VESSEL IN A MAGNETIC FIELD. R.Causse and Y.Poirier.
C.R. Acad. Sci. (France), Vol. 251, No. 9, 1056-8 (Aug. 29, 1960). In French.

If the effect of the currents on the applied field is neglected, simple differential equation for the vorticity is set up and solved terms of Bessel functions, the full solutions being given for the rotation being suddenly started or stopped. H.N.V.Temper

3045 INSTABILITY OF FLOW BETWEEN PARALLEL PLANES WITH A COPLANAR MAGNETIC FIELD.
P.T.Wooler.
Phys. of Fluids (USA), Vol. 4, No. 1, 24-7 (Jan., 1961).

The equations determining the growth of three-dimensional disturbances in the presence of a coplanar magnetic field, which i not parallel to the flow, are shown to be similar to those which determine the growth of two-dimensional disturbances when the field is parallel to the flow. When the field is not parallel to the flow the critical Reynolds number for the flow is shown to be finit for disturbances propagated in a certain direction. A consequence of this result is that the analogue of Squire's theorem does not hold, in general, when the magnetic field is not in the flow directi

3046 THE MOVEMENT OF A PISTON IN A CONDUCTING [FLUID] MEDIUM. V.V.Gogosov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 1, 30-2 (Nov. 1, 1960). In Russian.

The piston moves at the same speed as the fluid near its surface; a magnetic field is supposed to stand perpendicular on the face of the piston. If the front of a compression, or rarefaction wave, or a combination of such waves, runs at various speeds against the piston, it can be shown that, given the speed of the piston, only special types of wave may be formed. Conditions for the existence of waves of different types are shown in graphs. [English translation in: Soviet Physics—Doklady (USA)]. R.Eisenschitz

3047 INTERACTION OF A STREAMING PLASMA WITH THE MAGNETIC FIELD OF A LINE CURRENT. J.Hurley.
Phys. of Fluids (USA), Vol. 4, No. 1, 109-11 (Jan., 1961).

The interaction between the magnetic field of a line current and a rare plasma streaming toward it is investigated. It is assumed that the field of the line current is confined to a cavity with the plasma particles specularly reflected in a thin layer of the cavity wall. The shape of the cavity wall and the field in the cavity are calculated.

3048 HYDROMAGNETIC AND PLASMA SCALING LAWS. A.Beiser and B.Raab.
Phys. of Fluids (USA), Vol. 4, No. 2, 177-81 (Feb., 1961).

The Buckingham II theorem is applied to derive two sets of dimensionless parameters; one set for the quantities in the equations of Maxwell and Navier—Stokes, and the other containing the quantities involved in the Boltzmann equation. Ten independent dimensionless parameters are thus derived, which represent a complete set of scaling laws for phenomena describable by the these equations and which contain among them the ordinary fluid-dynamic scaling parameters: the Mach and Reynolds numbers.

3049 WAVES OF FINITE AMPLITUDE IN A MULTI-COMPONENT MEDIUM. V.S.Tkalich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 73-7 (July, 1960). In Russian.

The flow of a mixture of different ions and the associated propagation of electromagnetic disturbances is specified by a simplified set of magnetohydrodynamic equations. If applied to "helical" movement, these equations are linear even if the amplitudes are finite. Thus, appropriate solutions of the equations are obtained and discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 1, 52-5 (Jan., 1961)]. R.Eisenschitz

3050 ATTENUATION OF A MOVING MAGNETIC FIELD IN A SHOCK TUBE. V.Vali and T.E.Turner.
Phys. of Fluids (USA), Vol. 3, No. 6, 1029-31 (Nov.-Dec., 1960).

Describes an experiment in which a magnetic field was applied to the discharge region in an electrically driven shock-tube. The decay of the field was determined from pick-up loops and is shown to agree in order of magnitude with the decay expected theoretically. H.N.V.Temperley

3051 INFLUENCE OF TENSOR CONDUCTIVITY ON CURRENT DISTRIBUTION IN A MHD GENERATOR. H.Hurwitz, Jr, R.W.Kilb and G.W.Sutton.
J. appl. Phys. (USA), Vol. 32, No. 2, 205-16 (Feb., 1961).

Magnetohydrodynamic generators may operate under conditions such that the product of electron cyclotron frequency and mean collision time is not small compared with unity. Accordingly, the electrical conductivity is a tensor rather than a scalar quantity. The influence of tensor conductivity on the electrical current distribution is investigated in two idealized situations, one pertaining to the entrance and exit regions of the generator and the other to the region near segmented electrodes. The calculations predict modifications of the internal impedance of the generator which can be described in terms of increases in the effective duct length and width.

3052 PHYSICAL PRINCIPLES OF MAGNETOHYDRODYNAMIC POWER GENERATION. R.J.Rosa.
Phys. of Fluids (USA), Vol. 4, No. 2, 182-94 (Feb., 1961).

Some phenomena apt to be of importance in a magnetohydrodynamic power generator are discussed. Particular attention is given to the effects of seeding on gas conductivity and to the Hall effect as it appears in nonuniform gases of finite extent. An experimental 10 kW magnetohydrodynamic generator is described. An arc wind tunnel or "plasma jet" is used as a convenient laboratory "furnace" to heat the working fluid. The generator's performance, including some observed Hall effects, is presented and discussed.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

3053 ELECTROMAGNETIC RADIATION CAUSED BY THE DIFFUSION OF ELECTRONS. G.A.Askar'yan.
Zh. eksper. teor. Fiz., Vol. 39, No. 1(7), 211-12 (July, 1960). In Russian.

Considers the emission of e.m. radiation caused by elastic multiple collisions of electrons created in a medium by some ionizing agent, e.g. ionized molecules. The effective generation of waves can be improved by increasing free paths of the electrons. [English translation in: Soviet Physics —JETP (USA), Vol. 12, No. 1, 151-2 (Jan., 1961)]. J.K.Skwirzynski

RADIATION FROM A CHARGED PARTICLE MOVING THROUGH A PLATE. See Abstr. 2036

3054 THE OPTIMUM LINE WIDTH FOR A REFLECTION CAVITY MASER. G.J.Troup.
Austral. J. Phys., Vol. 13, No. 3, 615-16 (Sept., 1960).

It is shown that there is a line width which gives a maximum gain-bandwidth product for a cavity maser. D.Walsh

3055 SEESAW MASER OPERATION. P.A.Forrester and W.B.Mims.
J. appl. Phys. (USA), Vol. 32, No. 2, 317-20 (Feb., 1961).

Cross relaxation between adjacent intervals may be used to secure an advantage in maser operation comparable to that obtained by "push-pull" pumping. Equations for the rate of change of populations in a scheme of four levels (A, B, C, D) when AC is pumped and cross relaxation takes place between BC, CD are formulated, and the steady-state condition corresponding to various assumptions regarding lattice relaxation is discussed. In an experimental investigation of maser operation based on this scheme and using ruby as the active material, an inversion of 0.9 : 1 was obtained at a signal frequency of 14.5 kMc/s when pumping at 24.5 kMc/s.

THEORY OF LASER OSCILLATIONS IN FABRY—PEROT RESONATORS. See Abstr. 2853

COUPLED MODE THEORY OF ELECTRON-BEAM PARAMETRIC AMPLIFICATION. See Abstr. 3011

3056 RELATIVISTIC THEORY OF THE PROPAGATION OF PLANE ELECTROMAGNETIC WAVES. C.L.Tang and J.Meixner.
Phys. of Fluids (USA), Vol. 4, No. 1, 148-54 (Jan., 1961).

Based on the complete set of equations of thermodynamics of irreversible processes of a fluid in electromagnetic fields, a relativistic theory of the influence of electromagnetic waves on a simple fluid is developed. In particular, the oscillations of the fluid induced by a plane electromagnetic wave are evaluated, and the energy—momentum tensor is determined. It is further conjectured that Minkowski's tensor and Abraham's tensor lead to the same result when matter is properly taken into account. The irreversible processes of heat conduction and viscosity accompanying the oscillations of matter are briefly discussed.

3057 REFLECTION AND TRANSMISSION OF ELECTROMAGNETIC WAVES AT ELECTRON DENSITY GRADIENTS. F.A.Albini and R.G.Jahn.
J. appl. Phys. (USA), Vol. 32, No. 1, 75-82 (Jan., 1961).

Solutions are obtained for the propagation of plane electromagnetic waves parallel to a gradient of free electron density, in the form of complex Airy functions. Reflection and transmission coefficients are derived for normal incidence on a linear "ramp" of electron density connecting a uniform dielectric gas with a uniform

ionized gas, as functions of ramp length and propagation exponent of the latter. Machine evaluations of typical cases of physical interest are displayed and discussed. A similar study is made of two-stage ramps of variable proportions, intended as second approximations to smooth profile transition zones. In each case, the reflection and transmission coefficients are found to depend strongly on ramp width over a range of several tenths of a wavelength, then to oscillate mildly toward the asymptotic values predicted from a WKB-type approximation. The results are less sensitive to the detailed shape of the electron density profile. Propagation through a finite slab of ionized gas bounded on each side by such linear transition zones is formulated and evaluated for typical cases. Asymptotic approximations for the linear ramp problem are found to be inadequate to cover the entire range of interest. The neglect of variation in collision frequency through the transition is discussed and justified for a broad class of equilibrium profiles.

3058 CLASSICAL THEORY OF THE ABSORPTION OF RADIATION BY PARTICLES. É.Le Roux.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1741-3 (Oct. 24, 1960). In French.

An expression is derived for the mean power absorbed by particles of given energy from a wave which is treated as a perturbation of a static field. J.Hawgood

3059 POLARIZATION OF DIFFRACTED ELECTROMAGNETIC WAVE. B.Karczewski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 8, 541-6 (1960).

Concerned with the relative usefulness of diffraction theories due respectively to Kirchhoff and Kottler in the study of the diffraction of electromagnetic fields in the neighbourhood of the boundary of a geometrical shadow. It is proved that the polarization of the diffracted wave is of the same type as that of the incident wave. V.G.Welsby

3060 APPROXIMATIVE FORMULAS FOR THE DIFFRACTED ELECTROMAGNETIC WAVE. I. B.Karczewski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 10, 703-8 (1960).

Kottler's formulation (1917) of Huygen's principle expresses the field in the shadow of an aperture in terms of the surface integral over the diffracting aperture and the curvilinear integral along its edge. Kottler's formulae are approximated in terms of integrals which are not singular in the neighbourhood of the boundary of the shadow; the results are applied to diffracted dipole waves. J.K.Skwirzynski

MICROWAVE ANALOG TO THE SCATTERING OF LIGHT BY NONSPHERICAL PARTICLES. See Abstr. 2887

3061 ON A SINGLE CAVITY POLARIMETER FOR THE 3 cm BAND. G.Raoult and R.Fanguin.
C.R. Acad. Sci. (France), Vol. 251, No. 11, 1169-70 (Sept. 12, 1960). In French.

A circular guide, excited in the H_{11} mode, forms the inner conductor of a coaxial cavity which is coupled to the guide by two identical probes at right angles to each other. It is shown that the amplitude of the field measured in the coaxial cavity by a crystal detector contains a terms proportional to the rotation of the H_{11} mode. E.A.Ash

3062 PROPAGATION OF H MODES IN A FERRITE-LOADED RECTANGULAR WAVEGUIDE WITH TRANSVERSE MAGNETIZATION. R.Alfandari and R.Pauchard.
C. R. Acad. Sci. (France), Vol. 251, No. 17, 1738-40 (Oct. 24, 1960). In French.

The magnetic field is applied in a direction at right angles to the direction of propagation and to the direction of polarization of the incident H_{no} mode. It is shown that under these conditions the incident mode is transformed to an H_{op} mode. Experimental verification of this conclusion is presented. E.A.Ash

3063 ANALYSIS OF THE STABILITY OF AN ELECTROMAGNETIC FIELD IN RECTANGULAR WAVEGUIDES WITH DISCONTINUITIES WITH DUE CONSIDERATION OF WALL CONDUCTIVITY. A.Turski.
Bull. Acad. Polon. Sci. (Poland), Vol. 7, No. 7-8, 477-84 (1959).

The analysis shows that under certain conditions of degeneracy, the effect of wall losses on obstacles is to give strong coupling between otherwise uncoupled modes. Examples of obstacles for which this effect is significant are given. E.A.Ash

3064 THE VARIATIONAL PRINCIPLE RELATING TO SYSTEMS OF EQUATIONS WITH COMMON EIGENVALUES. APPLICATION TO THE CALCULATION OF THE PROPAGATION CONSTANT OF ELECTROMAGNETIC WAVES IN ANISOTROPIC GUIDES. L.Cairó and T.Kahan.
C.R. Acad. Sci. (France), Vol. 251, No. 18, 1865-7 (Oct. 31, 1960). In French.

A general variational principle is established and is then applied to the systems of equations governing the propagation constant of electromagnetic waves in gyromagnetic wave guides. V.G.Welsby

3065 BACKWARD WAVES IN LONGITUDINALLY MAGNETIZED FERRITE RODS.
A.W.Trivelpiece, A.Ignatius and P.C.Holscher.
J. appl. Phys. (USA), Vol. 32, No. 2, 259-67 (Feb., 1961).

A quasi-static approximation ($\nabla \times H = 0$) is used to investigate the backward waves that propagate along a longitudinally magnetized ferrite rod. These waves propagate in the frequency range where the permeability of the ferrite is negative, $\gamma H_0 < \omega < \gamma H_0 [1 + (M_0/\mu_0 H_0)]^{1/2}$, and can have a phase velocity much smaller than the velocity of light. The quasi-static approximation is shown to be valid whenever the free-space wavelength is greater than the circumference of the ferrite rod. Travelling-wave interaction of a drifting electron stream with these backward waves is considered, and a start-oscillation length of 1 in. at 4000 Mc/s is shown to be theoretically possible for a 600 V, 0.4 mA electron beam. Experimental verification of these waves is provided by measuring the phase velocity and signal strength along a longitudinally magnetized ferrite rod that completely fills a waveguide. Phase velocities as small as one one-hundredth of the velocity of light are measured.

POSSIBLE LONG-RANGE COMMUNICATIONS LINK BETWEEN GROUND AND LOW-ORBITING SATELLITES. See Abstr. 1546

3066 WAVE PROPAGATION IN A MOVING PLASMA. F.L.Scarf.
Amer. J. Phys., Vol. 29, No. 2, 101-7 (Feb., 1961).

The electromagnetic properties of a moving plasma are examined in terms of the index of refraction and the Fresnel drag. Simple models are used to illustrate the basic mechanism of electromagnetic propagation and the dependence of the drag coefficient on the parameters of the plasma.

3067 NONLINEAR INTERACTION OF AN ELECTROMAGNETIC WAVE WITH A PLASMA LAYER IN THE PRESENCE OF A STATIC MAGNETIC FIELD. I. THEORY OF HARMONIC GENERATION. R.F.Whitmer and E.B.Barrett.
Phys. Rev. (USA), Vol. 121, No. 3, 661-8 (Feb. 1, 1961).

The theory of electromagnetic wave propagation through an anisotropic ionized layer, including the effects of the nonlinear terms in the Boltzmann transport equation, is presented. The method of solution of the nonlinear equations involves an expansion of all of the dependent variables in a Fourier series in time. The differential equations describing wave propagation are then solved, for each frequency in the series, for plane wave propagation, including all of the reflections within the plasma layer. A solution in closed form is obtained, under small signal conditions, for the field at the h-th harmonic in the Fourier series. A discussion is given of the properties of the wave at the second harmonic frequency as a function of the d.c. magnetic field strength, the electron density, the electron-neutral particle collision frequency, the field strength of the incident wave, and the thickness of the plasma layer.

3068 GENERATION OF VERY LOW FREQUENCY NOISE IN THE EXOSPHERE BY THE CHERENKOV EFFECT. R.Gendrin.
C.R. Acad. Sci. (France), Vol. 251, No. 10, 1122-4 (Sept. 5, 1960). In French.

Considerations of the trajectory followed by the energy of a very low frequency wave directed along the magnetic field show that there are two modes of propagation, of which one is difficult to observe for the case of isotropic emission of all frequencies. It is suggested that the Cherenkov effect caused by relatively slow solar particles may be the mechanism whereby noise is generated and propagated in this mode. G.M.Brown

3069 HIGH-FREQUENCY RADIO-WAVE BLACK OUTS AT MEDIUM AND HIGH LATITUDES DURING A SOLAR CYCLE. C.Collins, D.H.Jelly and A.G.Matthews.
Canad. J. Phys., Vol. 39, No. 1, 35-52 (Jan., 1961).

Recent studies at the Defence Research Telecommunications Establishment, Ottawa, comparing v.h.f. riometer and h.f. ionosonde data for the International Geophysical Year, have shown that the two types of absorption events, "polar cap" and "auroral", can be identified in the occurrence patterns of ionosonde black-outs. A study based on this comparison has been made of all black-outs observed at a number of medium- and high-latitude ionosonde stations during the period 1949 to 1959. It has been found that the two kinds of absorption events show markedly different variations during the 11 years. Several other temporal and spatial features of the phenomena are also discussed.

3070 METHOD OF STUDYING TRAVEL TIME ANOMALIES OF HIGH FREQUENCY RADIO WAVES.
G.Lerfald and P.Scheibe.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1309-11 (Dec., 1960).

A device utilizing pulse techniques was built for automatic measurement of changes in radiowave travel times. The equivalent uses a combination of amplitude, time, and frequency selection for discrimination against unwanted signals. The received signals from U.S. time standard station WWV are sampled at 1 sec intervals to measure changes in the time of reception of the 1 sec timing pulses transmitted by WWV. The changes in travel time can give information on the vertical velocity of a virtual reflection point-in the ionosphere and other factors of interest in the study of the ionosphere.

NONLINEAR WAVE PROPAGATION IN THE IONOSPHERE.
See Abstr. 2982

Radiofrequency Spectroscopy Techniques

3071 MEASUREMENT OF THE RELAXATION TIME T_1 BY MODULATION OF THE RADIOFREQUENCY FIELD AND DETECTION OF THE VARIATION OF MAGNETIZATION ALONG THE EXTERNAL FIELD DIRECTION.
J.Hervé and J.Pescia.
C.R. Acad. Sci. (France), Vol. 251, No. 5, 665-7 (Aug. 1, 1960). In French.

The method involves modulating the microwave power saturating a resonance at a very high frequency around $1/T_1$. Detectors sensitive to either the amplitude of the signal induced in a pick-up coil, or the signal component in phase or in quadrature with the exciting modulation may be used to measure T_1. One needs to be able to alter the microwave power level by a known fraction but it is not necessary to know the absolute power level. J.M.Baker

3072 A NUCLEAR QUADRUPOLE RADIOSPECTROMETER.
E.I.Fedin and G.K.Semin.
Radiotekhnika i Elektronika (USSR), Vol. 4, No. 1, 127-8 (Jan., 1959). In Russian.

Describes a system for observing quadrupole resonance constructed from standard equipment, having a resolution of 10^{-6}.
R.C.Glass

3073 FREQUENCY STABILIZATION SCHEME FOR THE POUND–WATKINS R.F. SPECTROMETER.
J.Jeener.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 27-8 (Jan., 1961).

A scheme is described for locking the frequency of a marginal oscillator r.f. spectrometer to that of an external standard. This makes it convenient to use such a spectrometer for high-resolution n.m.r. work.

3074 COMPARISON OF THE SENSITIVITIES OF THE BEAM MASER AND CAVITY ABSORPTION SPECTROMETERS. Y.Beers.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 23-7 (Jan., 1961).

A formula for the signal-to-noise ratio of a maser spectrometer is derived by considering it as a special case of a cavity spectrometer. This formula is consistent with evaluations made by previous authors but is more convenient for comparison with an absorption cavity spectrometer. In applications where high resolution is not a requirement, the pressure and power level in an absorption spectrometer may be made very large so that its sensitivity can be superior to that of the maser. However, if it is operated to obtain the highest possible resolution, its sensitivity may or may not be superior to that of the maser, depending upon the frequency and upon other conditions. In the situation of greatest interest, in which the linear dimensions of the cavity are scaled in proportion to the wavelength and in which it is sufficiently large to make the effect of collisions between the molecules and the walls negligible, it is shown that the sensitivity of the maser relative to the absorption spectrometer varies inversely with the frequency. The theory is illustrated by calculations pertaining to spectrometers designed for the ND_3 inversion spectrum at 1500 Mc/s. From these calculations it can be inferred that, with the best available techniques, the two instruments would have about equal sensitivity in the region of 1500 to 2000 Mc/s, while at lower frequencies the maser would have higher sensitivity and the absorption spectrometer would have higher sensitivity at higher frequencies.

NUCLEAR PHYSICS

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

3075 VARIABLE SENSITIVITY AUTOMATIC IONIZATION CHAMBER. H.V.Neher.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 48-9 (Jan., 1961).

An all-quartz electroscope system is described whose sensitivity may be varied over a wide range by changing one potential. Like other previously described systems, it accumulates a definite quantity of electric charge, for given potentials, and then automatically recharges itself. When this recharging occurs an electrical pulse may be taken off for recording purposes. It is possible to change the sensitivity by a factor of 500.

3076 A METHOD FOR CHARGED PARTICLES SELECTION.
N.Cindro.
Period math.-phys. astron. (Yugoslavia), Vol. 15, No. 2, 113-18 (1960).

The particles of greatest specific ionization from a nuclear reaction may be distinguished by detection in an inorganic scintillator cleaved or evaporated to a thickness just sufficient to stop them. A NaI(Tl) crystal of thickness 270 mg cm^{-2} was used to distinguish 15 MeV deuterons inelastically scattered from Al from the protons from stripping. A 20 mg cm^{-2} layer of CsI(Tl) evaporated on to quartz allows 8.6 MeV α-particles from the $O^{16}(n,\alpha)C^{13}$ reaction (with 14.5 MeV neutrons) to be separated from the deuterons and protons.
A.E.I. Research Laboratory

3077 HIGH PRESSURE GAS SCINTILLATORS.
C.E.Engelke.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 32-5 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Observations of scintillation pulse heights were made at pressures up to 75 atm in xenon and argon, and in mixtures of nitrogen and xenon. Diphenyl stilbene was used as a wavelength shifter. The most salient feature is that in all cases pulse height is approximately independent of pressure at pressures over a few atmospheres. The nitrogen–xenon and neon–xenon mixtures were used as neutron detectors via the N^{14} (n,p), N^{14} (n,α) and Ne^{20} (n,α) reactions. The resolutions achieved, particularly in nitrogen–xenon mixtures (pulse height sometimes down to 1/40 of pure xenon) allow a good estimate to be made of the number of photons detected per unit energy loss in the scintillator.

3078 PULSE SHAPE DISCRIMINATION IN A PLASTIC SCINTILLATOR.
F.D.Brooks, R.W.Pringle and B.L.Funt.
IRE Trans Nuclear Sci. (USA), Vol. NS-7, No. 2-3, 35-8 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A plastic scintillator was developed which shows a decay time dependent upon energy loss per unit distance, and hence is suitable for use with pulse shape discrimination methods. This scintillator was employed in conjunction with an improved discrimination system and the data were analysed on a two-dimensional analyser which provided a matrix of 72 × 64 channels. At a bias level where 99% of the electron scintillations were eliminated, it was possible to obtain almost 100% counting efficiency for recoil protons of 2 MeV, and the scintillator was useful for protons down to 0.5 MeV. The influence of various monomers, polymerization conditions, scintillating solutes, and secondary solvents was investigated, and a preliminary survey of the effects of these variables on pulse shape discrimination is presented.

3079 PROGRESS IN PHOTOMULTIPLIER TUBES, SCINTILLATION INSTRUMENTS AND IMAGE INTENSIFIERS. J.Sharpe.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 44-51 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Reviews recent work at E.M.I. Ltd. (England) on photomultipler tubes for tritium counting and for other specialized purposes, including short resolving time applications. Data on spread of parameters for production tubes of various types are also given. Details of health physics instruments based on scintillation techniques are briefly outlined and a new tube designed for these is described. Work on image intensifiers is also in progress.

3080 SPACE SCINTILLATOR-DETECTOR DISTINGUISHING BETWEEN PROTONS AND ELECTRONS.
S.D.Bloom. R.C.Kaifer and C.D.Schrader.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 170-4 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A space scintillator detector was designed and tested which meets the following requirements: (1) detection and separation of protons with energy greater than 1.5 MeV and electrons with energy greater than 50 keV; (2) power consumption of less than 350 mW; and (3) weight less than 5 lb. The basis detector consists of a stilbene scintillator on an R.C.A. 6199 photomultiplier (or the C7151C ruggedized model). The electron–proton separation is accomplished through a circuit which makes use of the different light decay times caused by electrons and protons in the scintillator. The entire package, including amplifiers, scalers and high-voltage supply, occupies a space 5 in. in diameter by 10 in. long. The unit was tested for thermal stability and vibrational shock. A second detector, not restricted to the above power and weight requirements, is being developed to obtain pulse-height information as well.

3081 THE SOLID-STATE IONIZATION CHAMBER.
S.S.Friedland, J.W.Mayer and J.S.Wiggins.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 181-5 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Shallow diffused silicon p–n junction detectors have been used as room-temperature particle spectrometers for protons, alpha-particles, heavy ions, and fission fragments. By the use of high base resistivity devices operated at high reverse biases (>200 V), the width of the sensitive volume has been extended beyond 0.5 mm, permitting linear response to protons up to 9 MeV. Improved diffusion techniques have resulted in more shallow diffusion depths so that the "window effect" is reduced, extending the low energy response to below 200 keV for alpha particles. Use of low-noise amplifiers has permitted observation of half-widths of the pulse height-distribution equivalent to 18 keV.

3082 SILICON P–N JUNCTION RADIATION DETECTORS.
G.L.Miller, W.L.Brown, P.F.Donovan and I.M.Mackintc
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 185-9 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Silicon p–n junction particle detectors were fabricated by diffusing phosphorus to various depths between 0.1 and 0.2 μ into high resistivity p-type silicon. Various base material resistivies were employed, ranging from 100 to 13 000 ohm cm. Diffusions we carried out both by the "gaseous" and the "paint-on" process. The devices ranged in area from 1 mm^2 to 1 cm^2, with the majority of detectors having an area of ~ 0.2 cm^2. Using 5.5 MeV α-particles and a 5 × 5 mm device, the best line width obtained was 20 keV. It was found that the 1 cm^2 devices give line widths of ~ 50 keV. The effect of the thickness of the n layer forming the front surface of the junction was investigated, and it is shown that 0.1 μ diffusions give essentially "windowless" detectors. Other properties that we examined are space charge generation of leakage current, charge collection efficiency as a function of bias and incident particle direction, and signal rise time.

3083 SILICON JUNCTIONS AS PARTICLE SPECTROMETEF
J.M.McKenzie and J.B.S.Waugh.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 195-9 (June-Sep 1960). [Proceedings of the Seventh Scintillation Counter Symposiu Washington, February, 1960].

Both Au–Si surface barriers and silicon p–n junctions opera satisfactorily as particle spectrometers. The use of high resistiv material gives a depletion region wide enough to stop high-energy protons, α-particles, and heavier ions. A resolution of 16 keV (width at half-maximum) for 6.04 MeV α-particles is obtained wit a junction depletion layer sufficient to stop 10 MeV α-particles. With the depletion region very close to the surface, β-particles in the range from 10 keV to several hundred keV are detectable. The pulse amplitude distribution from Co^{57} indicates the presence of t two well-known lines at 115 and 129 keV. An attempt has been ma to correlate the observed performance with the semiconductor par meters and the diode static characteristics.

3084 INTRODUCTION TO SEMICONDUCTOR PARTICLE DETECTORS. W.L.Brown.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 2-10 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Considers the physical processes which govern the operation semiconductor particle detectors. Discusses the production of hole–electron pairs by energetic particles in solids; the motion of pairs under the influence of an electric field and in the presence of trapping and recombination; the current wave-shape resulting from transport of these carriers; the production of high electric fields t facilitate transport in single conductivity and junction devices; and the influence of high densities of holes and electrons along particle tracks on the transport processes.

3085 PERFORMANCE OF SILICON SURFACE BARRIER DETECTORS WITH CHARGE SENSITIVE AMPLIFIERS
J.L.Blankenship and C.J.Borkowski.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 17-20 (Jan., 1961) [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Silicon surface-barrier diode detectors of 1 cm^2 and 25 mm^2 sensitive area gave pulse height spectral resolutions of 17 keV and 13.5 keV (f.w.h.m.)respectively, for 5.5 keV alpha particles. Reverse currents at 500 V bias were less than 1×10^{-6} A/cm^2 wit breakdown in excess of 1000 V. A charge sensitive amplifier contributes 3.5 and 10 keV noise (f.w.h.m.) with an input capacitive loading of 20 and 180 pF respectively.

3086 HIGH RESOLUTION STUDY OF NUCLEAR REACTION BY P–N JUNCTION DETECTORS.
G.Amsel, P.Baruch and O.Smulkowski.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 21-8 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Deals with the problems which arise from the use of p—n junctions for the detection of particles emitted in nuclear reactions. The mechanism which allows the differentiation between different types of particle is explained. The use of slit-shaped detectors for maximum resolution is considered. Typical spectra obtained in the study of the following are presented: $O^{16}(d,d)O^{16}$, $O^{16}(d,\alpha)N^{14}$, $O^{18}(d,\alpha)N^{16}$, $O^{18}(p,\alpha)N^{15}$.

3087 TRANSISTOR FORM OF NUCLEAR PARTICLE DETECTOR. R.L.Williams and P.P.Webb.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 35-42 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

A transistor particle detector was fabricated using 20 000 ohm cm p-type silicon. With such high resistivity silicon and a wafer 10 mils thick, a bias voltage of 30 to 40 V extends the depletion layer almost completely through the wafer, leaving a thin p-region so that the whole wafer becomes a transistor. A particle entering the device through the collector depletion layer produces ionization in this layer which is quickly swept out. The charge separation is such that the emitter is forward biased and a transistor pulse current flows subsequent to the collector diode current.

3088 APPLICATION OF SOLID STATE DETECTORS TO HIGH ENERGY PHYSICS.
G.L.Miller, B.M.Foreman, L.C.L.Yuan, P.F.Donovan and W.M.Gibson.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 73-8 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

All charged particles exhibit a minimum in their $-dE/dX$ versus E behaviour. This minimum occurs at relativistic velocities, and corresponds to an energy loss of approximately 1.7 MeV gm^{-1} cm^2 for all particles. The application of solid state detectors at high energies depends on obtaining good signals from these minimum ionizing events. Detectors for this application should be large in area, have reasonably thick depletion layers, and a low series resistance to insure fast rise time. Low noise is not a prime requirement, however, since the Landau effect in any case limits the resolution to a low value. Using an analysing magnet and counter telescope at the Brookhaven cosmotron, diffused silicon junctions of up to 1.5 cm diameter were investigated using minimum ionizing particles. The signal-to-noise ratio obtained is ~10 : 1 and the resolution ~30%.

3089 SEMICONDUCTOR PARTICLE COUNTERS AT LOW TEMPERATURES.
F.J.Walter, J.W.T.Dabbs and L.D.Roberts.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 79-82 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Studies of the behaviour of semiconductor surface-barrier counters were made in the temperature range 0.2^0-300^0K. A simple model which appears to describe the observed behaviour is presented. Mountings suitable for low temperature applications are described.

3090 TEMPERATURE BEHAVIOR OF P—N JUNCTION DETECTORS. R.J.Grainger, J.W.Mayer and J.W.Oliver.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 116-23 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Experimental results are presented in graphical form and discussed.

3091 HOMOGENEOUS SOLID STATE IONIZATION DETECTOR.
J D.van Putten and J.C.Vander Velde.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 124-8 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

A gold-doped silicon crystal was used to measure the most probable energy loss and energy-loss distribution of π^- mesons at 1.50 BeV/c and 2.55 BeV/c. The crystal used was 2 cm in diameter and 0.25 cm thick. The preparation of the detector is discussed. The results confirm the existence of a density effect in the relations describing the dependence of the most probable energy loss on particle momentum. The energy-loss distribution appears to be broader than the predicted width.

3092 ALLOYED SILICON DIODES AS PARTICLE COUNTERS.
H.D.Engler.
Nukleonik (Germany), Vol. 2, No. 6, 215-22 (Nov., 1960). In German.

Si p—n diodes alloyed with a thin gold foil were successfully used for the counting of β-particles, γ-photons and neutrons, and for α-particle spectrometry in the medium energy region. The energy resolution in the case of ThC-ThĆ α-spectra was 2-4% (E = 8.78 MeV for ThĆ α-particles) and the pulse rise time was smaller than 0.15 μsec, this being the limit imposed by the amplifier, in measurements with Po α-particles. The construction of these detectors is described in detail, and their temperature behaviour, signal to noise ratio, energy resolution and variation of pulse height with applied potential and particle energy are discussed.

I.C.Demetsopoullos

3093 A MAGNETIC ANALYSER FOR THE STUDY OF NUCLEAR REACTIONS. G.F.Timushev.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 22-30 (Jan.-Feb.). In Russian.

A brief account of the theory is given for a magnetic analyser with double focusing and semiannular pole pieces. The principal specifications of the analyser are: mean radius of pole pieces 50 cm; relative solid angle 3.1×10^{-4}; maximum field in the gap 12 000 Oe; resolving power 0.1% for source; detector slit dimensions 1×30 mm^2. The total weight of the analyser is 4 tons. [English translation in: Instrum. exper. Tech. (USA), No. 1, 21-9 (Jan.-Feb., 1958; publ. April, 1959)].

3094 THE NITROUS OXIDE DOSIMETER.
R.W.Hummel and J.A.Hearne.
Nature (GB), Vol. 188, 734-5 (Nov. 26, 1960).

A preliminary note on an investigation of the radiolysis of nitrous oxide. The results of absolute measurements based on tritium as an internal source were compared with measurements based on ferrous or ceric sulphate dosimetry, using Co^{60} γ-rays or 4 MeV X-rays as external sources. Good agreement between the two methods was obtained provided irradiation took place in vessels with internal diameters greater than about 15-20 mm.

C.F.Barnaby

Track Visualization

3095 DIFFUSION CLOUD CHAMBER WITH A VACUUM JACKET. A.A.Silvidi and D.Marn.
Amer. J. Phys., Vol. 29, No. 2, 99-101 (Feb., 1961).

A diffusion cloud chamber with a vacuum jacket is tested experimentally for its effectiveness in increasing the sensitive area of the chamber. Evidence is presented which indicates that such a jacket can increase the effective area for observing tracks.

3096 LIQUID-HYDROGEN BUBBLE CHAMBER.
V.Z.Kolganov, A.V.Lebedev, S.Ya.Nikitin and V.T.Smolyankin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 31-4 (Jan.-Feb.). In Russian.

The chamber has a volume of 1 litre and a diameter of 10 cm. A description is given of a reliable method for vacuum sealing the glass windows to the frame of the chamber at low temperatures. Photographs are shown of particle tracks obtained with the neutron beam of the synchrocyclotron of the Joint Institute for Nuclear Research. [English translation in: Instrum. exper. Tech. (USA), No. 1, 30-4 (Jan.-Feb., 1958; publ. April, 1959)].

3097 A PHOTOGRAPHIC SYSTEM FOR LARGE HYDROGEN BUBBLE CHAMBERS. A.V.Belonogov, A.G.Zel'dovich, V.Z.Kolganov, L.G.Landsberg, A.V.Lebedev, S.Ya.Nikitin, V.T.Smolyankin and A.P.Sokolov.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 38-41 (Jan.-Feb.). In Russian.

A system is described for illuminating and photographing tracks in a chamber from one side. The method was used on a 10 cm hydrogen bubble chamber. The scattering of light by a bubble in a liquid is calculated. [English translation in: Instrum. exper. Tech. (USA), No. 1, 39-42 (Jan.-Feb., 1958; publ. April, 1959)].

3098 LARGE FREON BUBBLE CHAMBER.
G.A.Blinov, M.F.Lomanov, A.G.Meshkovskii, Ya.Ya.Shalamov and V.A.Shebanov.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 35-8 (Jan.-Feb.). In Russian.

The volume available for observation of particles is 17 litres; the chamber works at room temperature and a pressure of 38 atm. The chamber is operated in conjunction with an accelerator and is also effective for the observation of tracks of cosmic-ray particles. The working liquid is a mixture of freon-12 and freon-13 (density approximately 1.2). [English translation in: Instrum. exper. Tech. (USA), No. 1, 35-8 (Jan.-Feb., 1958; publ. April, 1959)].

SYSTEM FOR COORDINATE MEASUREMENT ON BUBBLE CHAMBER PHOTOGRAPHS. See Abstr. 2583

3099 DEVICE FOR MEASURING GAPS IN PARTICLE TRACKS IN EMULSIONS. A.P.Zhdanov, M.I.Kolpakov, V.N.Kuz'min, R.M.Raguzin and P.I.Fedotov.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 46-7 (Jan.-Feb.). In Russian.

In high-sensitivity emulsions the tracks of charged particles do not consist of individual grains at the end of the path, but rather grain bunches which are separated by gaps. To identify particles in this case, use is made of a method which is similar to that proposed by Hodgson (Abstr. 8112 of 1950) for counting grains: one measures the total length of the gaps L between bunches; the total length L, as a function of the residual range, then serves to identify the particle. To plot this function, the quantity L must be measured over a section of track (approximately 50μ). A special instrument has been developed for this purpose (Abstr. 563 of 1954). [English translation in: Instrum exper. Tech. (USA), No. 1, 48-9 (Jan.-Feb., 1958; publ. April, 1959)].

3100 FADING OF TRACKS OF ALPHA-PARTICLES IN NUCLEAR EMULSIONS AND A METHOD FOR THE CORRECTION OF THE VISIBILITY OF ALPHA-PARTICLE TRACKS IN THE GAMMA BACKGROUND.
Z.Lewandowski, M.Makowska-Rzeszutko and Z.Wróbel.
Acta phys. Polon. (Poland), Vol. 19, No. 5, 599-603 (1960).

Exposure of Agfa-K2 and NIKFI-K emulsions to the vapour of 6% hydrogen peroxide solution at 32°C for one hour is recommended for fading the gamma background and leaving the heavy-particle tracks almost unchanged. E.J.Burge

ENERGY DETERMINATION OF ELECTROMAGNETIC CASCADES. See Abstr. 3301

3101 BEVATRON EXPERIENCE WITH A HOMOGENEOUS LUMINESCENT CHAMBER.
L.W.Jones, K.Lai, R.Newsome and M.L.Perl.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 145-50 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

A luminescent chamber system consisting of a 4 in. NaI crystal and four image tubes was studied using pions of 2 BeV/c. Gating times of 3 to 10 μsec were used in particle fluxes of up to 10^4 per pulse through the scintillator. The potentialities and problems of such a system are discussed and illustrated with stereoscopic photographs of pion interactions.

3102 PRESENT STATUS OF IMAGE INTENSIFIER SYSTEMS. K.Lande, A.K.Mann, K.Reibel and D.H.White.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 121-6 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The luminescent-chamber image-intensifier system can combine the advantage of visual measuring techniques with the advantage of the high time-resolution of electronic counters. To realize this, it is necessary that a system satisfy three basic requirements: (1) it should be a competent image-producing device capable of yielding pictures of minimum ionizing particle tracks with small distortion and with sufficient spatial resolution to permit adequate measurements to be made; (2) it should be a gated system with a time resolution of about 1μs or less; and (3) it should utilize luminescent chambers large enough to allow useful experiments to be done, which demands high efficiency of the image preserving optical coupling between chamber and intensifier. The extent to which presently existing systems meet these requirements is described and improvements likely to be forthcoming from developmental efforts now in progress are indicated.

OPTICAL COUPLING OF A SCINTILLATION CHAMBER TO AN IMAGE-INTENSIFYING TUBE. See Abstr. 2851

NUCLEAR FIELD THEORY

3103 PARITY.
G.P.McCauley.
Amer. J. Phys., Vol. 29, No. 3, 173-81 (March, 1961).

The concept of parity conservation is the quantum mechanical expression of the intuitively reasonable hypothesis that the laws of physics do not distinguish between a system and its mirror image. This article attempts to provide a nonmathematical account of the importance of conservation laws in elementary-particle physics and the way in which this hypothesis was built into present thought in this field. The steps by which it was first called into question in the case of certain weak interactions are outlined, and a brief account is given of the beautiful experiments which demonstrated that the concept was not universally valid.

3104 CONSERVATION OF COMBINED PARITY AS A FUNDAMENTAL SYMMETRY LAW OF NATURE.
V.G.Solov'ev.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 1, 159-63 (May, 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2(68), No. 3, 451-4 (May-June, 1959).

Discusses the possibility that CP-invariance is fundamental, with parity conservation as a consequence for some processes only. Experimental tests for parity conservation in strange-particle processes as described. J.C.Taylor

THE CLASSICAL FIELD THEORY OF MATTER AND ELECTRICITY. See Abstr. 2679-80.

3105 A TWO-DIMENSIONAL RELATIVISTIC FIELD THEORY.
P.Federbush.
Phys. Rev. (USA), Vol. 121, No. 4, 1247-9 (Feb. 15, 1961).

A particular two-dimensional relativistic field theory is considered. In some limit as the masses of the theory go to zero it approaches the Thirring model (Abstr. 2758 of 1958). By means of a formal transformation of the field operators the Hamiltonian is reduced to that of a free field. An improved perturbation expansion can be written down, necessitating only wave-function renormalization, and it appears that the renomalized theory is consistent. The S-matrix can be exhibited exactly, and though it leads to no physical scattering, it is not equivalent to the unit matrix. Finally the renormalized current operator is displayed as a suitable limit of products of the renormalized field operators. The form of the result clearly separates the consistency problem in quantum electrodynamics from that of the "photon mass".

3106 ON THE NON-LOCAL BOUNDARY CONDITION IN QUANTUM FIELD THEORY. H.Shimazu.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 821-8 (May, 1960).

The nonlocal boundary condition introduced by Bogolyubov et al (1958) is useful for eliminating the difficulty of negative probability concerning the indefinite metric in Hilbert space. Their theory is developed in the S-matrix formalism and does not give a causal description of the physical state. A causal description is given here in the form of an ordinary Schrödinger equation. The Hamiltonian is not hermitian in general, though it gives the unitary S-matrix. Such a characteristic situation is discussed by using a simple model.

3107 THE NORMALIZATION CONSTANTS OF THE STATE VECTORS IN FIELD THEORY. M.A.Braun.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 737-40 (Sept., 1960). In Russian.

Using weak convergence methods it is shown that the normalization constant of the n-particle state in field theory introduced by Van Hove (Abstr. 2689, 4847 of 1956) and de Witt (Abstr. 924 of 195 is equal to the product of the vacuum constant and a factor Z^n, where Z is the renormalization constant of the wave-function in the conventional field-theory formalism. [English translation in: Soviet Physics—JETP (USA)].

3108 NONLOCAL INTERACTION, CAUSALITY AND INTEGRABILITY CONDITION. Y.Miyatake.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 524-6 (March, 1960).

It is claimed that, in a nonlocal Lorentz-invariant field theory, it is possible, even if observable quantities do not commute at space-like separated points, to have the vacuum expectation value of their commutator zero. J.E.Paton

3109 AMBIGUITY OF $\partial D_{S.C.}(x)/\partial x^2$ AND CAUSALITY. I.Fukada.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1028-34 (June, 1960).

In the definition of the derivatives of the causal function $D_C(x)$ a new type of ambiguity is pointed out. It can be removed by causality requirements, but not by renormalization. Or in other words, an effect of causality requirements in the graphical calculation is made explicit.

3110 EQUATIONS FOR THE MANDELSTAM SPECTRAL REPRESENTATION FUNCTIONS. K.A.Ter-Martirosyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3, 827-40 (Sept., 1960). In Russian.

Using the unitarity conditions, a closed equation set is derived for the Mandelstam spectral representation functions, which is completely symmetric with respect to the three channels of the four particle vertexes. The consistency of the equations which follow from the unitarity conditions in various channels is examined. If the integral representation is written down with subtraction, one obtains a set of coupled equations for the spectral functions which depend on two variables and on one variable. Consistent iteration of the equations obtained corresponds to taking into account the contribution (or part of the contribution) from a number Feynman graphs consisting of two parts connected by two lines. The equation set goes over to one of the Chew–Mandelstam type if terms containing the spectral functions depending on two variables are neglected. [English translation in: Soviet Physics–JETP (USA)].

3111 ON THE REPRESENTATION OF THE CANONICAL COMMUTATION RELATION OF BOSE FIELDS. H.Fukutome.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 989-1002 (June, 1960).

A representation of the canonical commutation relation of Bose fields is given in a way which is independent of the choice of the bases of the test functions and covariant with respect to the Euclidean transformation of the coordinate system. It is shown that the representation is characterized by an integral on the conjugate space L^* of the space L of the test functions and a real function on $\Sigma \otimes L^*$ where Σ is the group of the transformations $f \to u^{-1}f + \varphi$; $f \in L^*$, $\varphi \in L$ and u is a Euclidean transformation of L^*. The conditions for the irreducibility of a representation and the unitary equivalence of the representations and the existence of unique vacuum state are given. An example of the inequivalent Euclidean covariant irreducible representations containing unique vacuum state is given.

3112 ASYMPTOTIC THEORY OF INTERACTING FIELDS WITHOUT HAMILTONIAN. T.Yoshimura.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 576-82 (April, 1960).

Asymptotic properties of the propagators and the vertex parts of quantized fields with interactions for which the Hamiltonian formalism is impossible are considered using Schwinger's theory of the Green functions (Abstr. 64-5 of 1952). Possibilities of divergence-free theories are suggested.

3113 SECOND QUANTIZATION AND LORENTZ INVARIANCE. S.Sato.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 717-30 (April, 1960).

The possibility of constructing a relativistically invariant theory using the particle representation is investigated. It is shown that the Hamiltonian formalism is not adequate in this representation. The general structure of the invariant S-matrix is investigated, and some correspondences to the ordinary theory are obtained. An application to Compton scattering is also made.

3114 ENERGY DISTRIBUTION OF BREMSSTRAHLUNG FROM LONGITUDINALLY POLARIZED ELECTRONS. B.K.Kerimov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1111-13 (Dec. 11, 1960). In Russian.

A generalization of the Bethe–Heitler formula for the energy spectrum is presented. The degree of circular polarization of the emitted radiation is calculated in the extreme relativistic limit. [English translation in: Soviet Physics–Doklady (USA)]. J.S.Dowker

3115 REMOVAL OF GHOST-POLE AND UNITARITY OF S-MATRIX. T.Ogimoto and K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 218-20 (Feb., 1960).

The consistency of the method of removing the ghost-pole proposed by Redmond (Abstr. 2054 of 1959) and Bogolyubov et al. ("preprint", possibly Abstr. 9258 of 1960) is investigated. It is concluded that their method contradicts the unitarity condition for the S-matrix and merely demonstrates the well-known fact that it is possible to remove the ghost-pole of the propagator by using a suitable cut-off.

3116 ASYMPTOTIC EXPANSIONS OF CHARGED-PARTICLE WAVE-FUNCTIONS. R.Peterkop.
Latv. PSR Zinat. Akad. Vestis (USSR), No. 9, (158), 79-84 (1960). In Russian.

The asymptotic behaviour of the wave-function of several charged particles is discussed in relation to scattering problems, such as ionizing collisions, in which the final state has such a wave-function. In terms of the coordinate r of the centre of mass of the charged particles, an asymptotic expansion in powers of r and log r is given. The results obtained are shown to be analogous to the classical treatment. R.F.Peierls

3117 REPRESENTATION OF SPACE INVERSION, TIME REVERSAL, AND PARTICLE CONJUGATION IN QUANTUM FIELD THEORY. F.A.Kaempffer.
Canad. J. Phys., Vol. 39, No. 1, 22-34 (Jan., 1961).

The unitary operators of space inversion and particle conjugation and the unitary factor of the antiunitary operator of time reversal can each be written in the form $e^{i\Omega}$, where Ω is the direct sum of two terms, $\Omega = \Omega_1\theta_1 + \Omega_2\theta_2$, with Ω_1, Ω_2 Hermitean bilinear forms in the creation and annihilation operators of the boson or fermion field under consideration, and θ_1, θ_2 singular operators which separate the appropriate half spaces needed for the formulation of the symmetry operations. Explicit expressions are given for the generators Ω in case of a non-Hermitean boson field of spin 0, and in case of a four-component fermion field of spin $\frac{1}{2}$.

3118 CLASSIFICATION OF COMPOSITE BOSONS IN THE SAKATA MODEL. Y.Yamaguchi.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 882-6 (May, 1960).

Assuming the Sakata model (Abstr. 6884 of 1957), in which p, n, Λ, are basic, all other strongly interacting particles being composite particles, and neglecting moderately strong interactions which contribute to N–Λ mass splitting, complete symmetry is found between three fundamental fields (referred to as global symmetry). Under this global approximation, the classification of two-baryon pair states — which are supposed to represent physical mesons — is described.

3119 A POSSIBLE SYMMETRY IN SAKATA'S MODEL FOR BOSONS-BARYONS SYSTEM. II. M.Ikeda, S.Ogawa and Y.Ohnuki.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1073-99 (June, 1960).

In Pt I (Abstr. 20053 of 1960) a possible symmetry among the proton, neutron and Λ-particle in Sakata's model was discussed and some physically interesting results in the boson-baryon system were obtained. This symmetry is equivalent to the invariance of the theory under transformations of the unitary group U(3) of degree three. The mathematical structure of the theory is studied in more detail.

3120 A UNIFIED MODEL FOR ELEMENTARY PARTICLES. Z.Maki, M.Nakagawa, Y.Ohnuki and S.Sakata.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1174-80 (June, 1960).

By extending the Sakata model (Abstr. 6884 of 1957) a unified model for elementary particles is proposed, the basic particles in the Sakata model being assumed to be constructed of the lepton and B^+, which is regarded as a new kind of matter. The full symmetry among the three basic particles and the symmetrical property of the weak interactions, which was recently pointed out by Gamba, Marshak and Okubo (Abstr. 10593 of 1959), come automatically from this model. The nature of B^+ and the new mechanics which accounts for the binding of B^+ to the lepton will be the central problem to be studied in the future.

THE ELECTROMAGNETIC THEORY OF PARTICLES.
See Abstr. 3060

3121 ON THE STRUCTURE OF THE ELEMENTARY PARTICLES. S. Maki, Y. Ohnuki and M. Yonezawa.
Progr. theor. Phys. (Japan). Vol. 25, No. 5, 1145–6 (abstr.) [1961].

Continuation of previous work on the "Nagoya model" (see preceding abstract). From an investigation of the mass formula for the composite particles in the Sakata model, it is shown that the B-matter has a charge-like character similar to the electric charge, i.e. $+\frac{1}{3}$. On the basis of this character of the B-matter, the mass formula for octet characters and the mass bound relation is reproduced. Of the physical basis is given for Yamaguchi's theory (1958) and his theory is developed. A conserved law of the basic universe within the compound particles is discussed. Remarks on a new boson baryon family and proton are given.

3122 THEORY OF RELATIVISTIC ROTATORS AND ELEMENTARY PARTICLES. I. T. Takabayasi.
Progr. theor. Phys. (Japan). Vol. 25, No. 5, 903–41, Mem. [1961].

With a view to formulating a unified model of elementary particles, the theory of relativistic rotators is developed. The physical concept of relativistic rotators is clarified, and a general theory is constructed on the basis of kinematical variables. Consideration of the physical properties of the internal rotational space leads to the definition of isospin and spin (helicity). Other internal variables of motion are also identified as mass and ordinary spin. Possible rotator models are classified according to the symmetries of the rotational part of the Lagrangian. Various previously known models are automatically reproduced in this way with their unified properties revealed. In addition, entirely new models also follow from this scheme.

EQUATIONS FOR ELEMENTARY PARTICLES AND THEIR INTERACTIONS IN CURVED SPACE-TIME. See Abstr. 3107

3123 ON THE MODEL OF ELEMENTARY PARTICLES. Y. Miyamoto.
Progr. theor. Phys. (Japan). Vol. 25, No. 1, 197–8 (Jan., 1961).

A scheme for making all elementary particles out of the four stable particles proton, electron, neutrino and gamma, plus an additional particle "C", is suggested. F. J. Squires

3124 MAJORIZATION OF FEYNMAN DIAGRAMS. A. A. Logunov, A. N. Tavkhelidze, I. T. Todorov and N. A. Chernikov.
Dokl. Akad. Nauk SSSR. Vol. 139, No. 4, 821–4, Dec. 1, 1961.
In Russian.

Three theorems are proved relating to the majorization of Feynman graphs, strongly connected, with an arbitrary number of external meson and nucleon lines, having three and only three lines at each vertex. [English translation in: Soviet Physics—Doklady (USA).] R. E. Peierls

3125 $\Delta(1\frac{1}{2}, \frac{1}{2}; 0)$ [S].
A. Salam and J. C. Ward.
Phys. Rev. Letters (USA). Vol. 5, No. 8, 390 (Oct. 15, 1960).

If it is postulated that the vacuum expectation value of the K_+^0 field is non-zero, a seemingly isotopic-spin conserving Δ-production-operator will possess matrix-elements with $\Delta I = \frac{1}{2}$ proportional to $\langle K_+^0 \rangle$. Parity nonconservation can be similarly interpreted if there exist K' mesons with opposite parity to K mesons and $\langle K'_+ \rangle \neq 0$. P. K. Kabir

3126 THEORY OF STRONG INTERACTIONS. J. J. Sakurai.
Ann. Phys. (USA). Vol. 11, No. 1, 1–48 Sep., 1960.

Following Yang and Mills (Abstr. 3791 of 1954), it is suggested that the three "internal" conservation laws — of baryon number, hypercharge and isospin — are associated with the existence of corresponding vector fields coupled linearly to the conserved current in each case, each coupling being characterized by a single universal constant. Various experimental data are put tentatively to qualitative support of this proposal, and certain theoretical arguments are made. No explanation is offered as to why the particles associated with these vector fields should be massive, nor is it proven that the theory is compatible with massive particles. P. K. Kabir

3127 ON CONSERVATION OF PROBABILITY IN THE LEE MODEL. F. Dennery and N. M. Kroll.
Nuclear Phys. (Internat.). Vol. 21, No. 2, 276–89 (Nov. (I), 1960).

The scattering treatment of the Lee model in an inadequate space with "single" or "complex" ghosts is extended to include more than one boson particle and to include heavy particle motion. It is shown that this extension now bound states of negative norm and negative energy appear which can via a scattering process lead to a decrease in probability in the theory.

3128 BOSON CURRENTS IN THE THEORY OF WEAK INTERACTIONS. W. R. Frazer and A. C. Stern.
Phys. Rev. (USA). Vol. 122, No. 3, 968–75 [Mar. 1, 1961].

A possible new method of introducing boson currents into the weak interaction is suggested. The Bose fields are assumed to obey the first-order Kemmer equation. In this way the boson and its currents enter the interaction in a symmetric manner. Three coupling constants are introduced according to the degree of isospin and strangeness symmetries of the currents. The interaction so obtained gives rise in a natural way to the $\Delta T = \frac{1}{2}$ selection rule and its violation, and also to last pairs modes and slow leptonic modes of hyperon decay. First-order calculations are performed for $K_{\mu 3}$, γ-γ, and π^0 decays. Calculations of the decay rates require sufficient information to determine the approximate magnitudes of the effective coupling constants. The first-order calculations are in accordance with the experimentally uniform distribution of π^0 energy in the Dalitz plot.

3129 SELECTION RULES FOR INTERACTION TYPES IN QUANTUM FIELD THEORY. S. Okubo.
Progr. theor. Phys. (Japan). Vol. 25, No. 2, 221–6 [Feb., 1961].

The Dirac equation is generalized to the form containing the γ_5 term, which is reduced to the Klein–Gordon equation when it is squared. Such a generalized quantum electrodynamics is proved to be equivalent to the usual quantum electrodynamics as far as the usual vector coupling is concerned. If the principle is adopted that the fermion must obey the generalized Dirac equation and that the equation including interaction is invariant under the similarity transformation, or what is reduced to the original Dirac equation, it is prohibited to introduce the Pauli term into quantum electrodynamics, because the Pauli term in the generalized Dirac equation violates the parity inversion and hand reversal invariance. It is also found that only the interaction terms of types A and T are selected in the universal Fermi interaction and in the case of the neutrino theory with a massless and a 2-component only the interaction of A and T are allowed by using the principle mentioned above. In these cases the parity inversion and particle–antiparticle transformation laws do not hold. If invariance under P, T and C transformation is adopted in the case of strong interactions, only one of the interaction types A and V remains for fermion–fermion or fermion–boson interacting systems.

3130 ON THE REDUNDANT SOLUTIONS OF THE SETHE–SALPETER EQUATION. Y. Ohnuki, Y. Takao and H. Umezawa.
Progr. theor. Phys. (Japan). Vol. 25, No. 2, 275–83 [Feb., 1961].

The canonical solutions of the Sethe–Salpeter equation are examined. It is shown that they are not permissible in quantum field theory. A special example of the soluble Sethe–Salpeter equation is presented to show that it actually has many redundant solutions.

3131 ON HIGH ENERGY LIMIT OF FERMION–FERMION INTERACTION. T. Yoshimura.
Progr. theor. Phys. (Japan). Vol. 25, No. 4, 569–75 [April, 1961].

The author investigates what asymptotic behaviour of the scattering part of the fermion–fermion interaction is compatible with Lehmann's spectral representation for the two-body propagator (Abstr. 9256 of 1954). In contrast to the results in Abstract 9256 of 1954 and Abstr. 9626 of 1958, it is shown that no term may be neglected in the equation for the fermion part.

3132 BETA DECAY AND THE WEAK INTERACTIONS. V. A. Simonenko.
Izvestia Akad. Nauk USSR. Vol. 25, No. 4, 453–82 Aug., 1961. In Russian. English translation in: Soviet Physics—Uspekhi. Vol. 4, No. 2, 357–83 [Sept.–Aug., 1961].

A short simple survey of present knowledge of weak interactions with particular attention to nuclear beta decay. No details are given. Suitable for the non-specialist. J. C. Taylor

FERMI THEORY OF BETA DECAY. FORMULAE FOR BETA-γ ANGULAR CORRELATION. See Abstr. 3408

3133 EXTRA SOLUTIONS OF THE DISPERSION RELATIONS AND RESONANCE SCATTERING.
O Barut and K.H.Ruei.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 300-9 (Nov.(5), 1960).
The connection between the extra solutions of the dispersion relations plus the unitary condition and the existence of unstable intermediary states is discussed. It is known for the potential scattering that both lead to a resonance behaviour in the cross-section. The dispersion relation and the unitarity condition assume, therefore, a physical system whose spectrum is enlarged by the inclusion of unstable intermediate states.

3134 TERTIARY AND GENERAL-ORDER COLLISIONS. II. L.M.Delves.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 275-308 (Oct. (4), 1960).
For Pt I, see Abstr. 3563 of 1959. The basis introduced in previous paper for describing collisions involving more than two free particles in ingoing or outgoing channels is discussed in more detail. With this formalism channel wave-functions for many-particle channels are formally identical to the usual two-particle wave-functions and require no special treatment. The scattering matrix referring to open channels is unitary and symmetric when many-particle channels are included. Its symmetries in the complex energy plane are also discussed. Long-range effects in many-particle channels are considered, and it is shown that these can modify the threshold behaviour of matrix elements given previously. Effective range expansions, valid for many-particle channels, are given for the reactance matrix and eigenphaseshifts.

3135 AN IMPROVED APPROXIMATION FOR SCATTERING PROBLEMS. II. P.Swan.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 233-6 (Nov. (5), 1960).
For Pt I see Abstr. 17251 of 1960. A method of calculating scattering phase-shifts developed in Pt I is improved for long-tailed potentials by using a better form factor $g_l(r)$, which takes into account distortion of the wave-function by the potential tail. A numerical comparison for ^3S and ^1S neutron–proton scattering is made for wells of Gaussian, exponential and Yukawa shape. Comparison of results with those Pt I shows a reduction in error of more than half for non-singular potentials for which satisfactory $g_l(r)$ can be constructed, such as the exponential potential. Singular potentials such as the Yukawa well give the least satisfactory results, because satisfactory $g_l(r)$ cannot be constructed in the usual simple way due to neglect of logarithmic terms in the distorted wave-function.

POLARIZATION OF NUCLEONS BY SCATTERING (REVIEW). See Abstr. 3175

3136 INTEGRAL REPRESENTATIONS OF BETHE–SALPETER AMPLITUDES. M.Ida.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1151-6 (June, 1960).
An integral representation is shown for the matrix element between the vacuum state and a one-particle state of the T-product of two field operators (two-body Bethe–Salpeter amplitudes). It is a generalization of the representation introduced by Wick (Abstr. 50 of 1955). The derivation makes use of the Lorentz invariance, microcausality, asymptotic conditions, spectral conditions plus the unitarity condition.

3137 SYMMETRY OF THE ND^{-1} SOLUTIONS FOR COUPLED SCATTERING AMPLITUDES.
J.D Bjorken and M.Nauenberg.
Phys. Rev. (USA), Vol. 121, No. 4, 1250 (Feb. 15, 1961).
It is proved that the ND^{-1} matrix solutions for coupled scattering amplitudes are symmetric provided the given discontinuity of the scattering matrix across the unphysical cut is symmetric.

3138 TESTS OF FORM OF THE ONE-PION EXCHANGE POTENTIAL.
R.Breit, M.H.Hull, K.E.Lassila and H.M.Ruppel.
Proc. Nat. Acad. Sci. USA, Vol. 46, No. 12, 1649-57 (Dec., 1960).
The one-pion exchange potential is often used to predict the "higher" phase shifts in nucleon–nucleon scattering. Various modified forms, with adjustable parameters, are tried in phase-shift analyses of scattering data over a wide energy range. The best fits are inconsistent with the original form. R.J.N.Phillips

3139 CONTRIBUTION FROM THE THREE-PION STATE TO THE AXIAL VECTOR COUPLING CONSTANT IN β-DECAY. Y.Fujii and S.Furuichi.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 251-72 (Feb., 1960).
The effect of the pion cloud on the ratio g_A/g_V in β-decay is investigated, assuming a conserved current for the vector interaction. The three-pion state is considered as the simplest state which might improve the result of the static theory, which gives $g_A/g_V=1$. According to the lowest-order perturbation calculation, the contribution from this state turns out to be of the positive sign and large. It seems promising to explain the observed ratio $g_A/g_V>1$ even when the decrease of the bare state probability is taken into account, unless the effect of the supression of the nucleon pair is too strong.

3140 MACROSCOPIC CAUSALITY AND ANALYTICITY OF SCATTERING AMPLITUDE IN QUANTUM FIELD THEORY. K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 859-70 (May, 1960).
On the basis of macroscopic causality and relativistic covariance it is shown that the scattering amplitudes are regular in the upper half plane as a function of the energy of the bombarding particle. This conclusion also holds for the theory in which the Hamiltonian does not exist, such as nonlocal field theory, so far as the theory is covariant. In order to satisfy macroscopic causality the scattering is investigated by means of the wave-packet formalism. A comparison with the result of non-relativistic theory is also discussed.

3141 ELECTROMAGNETIC SCATTERING OF SPIN $\frac{1}{2}$ PARTICLES. L.G.Moroz.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 589-90 (Sept., 1960). In Russian.
A general formula is derived for electromagnetic scattering of two different longitudinally polarized spin $\frac{1}{2}$ particles. [English translation in: Soviet Physics–JETP (USA)].

3142 THE AXIOMATIC METHOD AND PERTURBATION THEORY. B.V.Medvedev.
Doklad. Akad. Nauk SSSR, Vol. 135, No. 5, 1087-90 (Dec. 11, 1960). In Russian.
The question of the sufficiency of the assumptions of the axiomatic approach to quantum field theory is discussed. It is proved that, in the framework of perturbation theory, the expansion of the S-matrix in powers of the coupling constant follows from the basic assumptions of the axiomatic approach, combined with assumptions about the transformation properties of the fields under consideration, with the same arbitrariness as in the conventional theory. [English translation in: Soviet Physics–Doklady (USA)]. R.F.Peierls

3143 A NOTE ON THE ORDINARY AND ANOMALOUS THRESHOLDS IN PERTURBATION THEORY. N.Nakanishi.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 284-6 (Feb., 1960).
For previous work, see Abstr. 17266 of 1960. Some further investigations are made for the singular point of the matrix element corresponding to the general Feynman graph.

3144 INCLUSION OF HOLE MOTIONS IN BRUECKNER THEORY. F.Iwamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 871-81 (May, 1960).
In order to include hole motions in the Brueckner method (Abstr. 3957 of 1955) a systematic theory is developed based on a familiar treatment of small oscillations of some dynamical system about the stable point. It is shown that a slight modification in the Bethe–Goldstone equation (Abstr. 5546 of 1957) enables one to take into account all effects coming from the couplings of particle–particle and hole–hole pairs with the same total momentum. Ground-state energy is expressed with the sum of zero point energy shifts of all hole pair oscillators. The superfluidity condition found by Bogolyubov, Tolmachev and Shirkov (1958) and by Cooper, Mills and Sessler (1959) is also derived as the condition for the stability of the degenerate Fermi gas state. An expression for the ground state vector is given. A comment is added on the interpretation of the perturbation expansion.

APPROACH TO EQUILIBRIUM OF A QUANTUM PLASMA. See Abstr. 2961

ELEMENTARY PARTICLES

3145 A RELATIONSHIP BETWEEN THE MATRICES OF VARIOUS TRANSITIONS AND MULTIPLE PROCESSES.
B.T.Vavilov and V.I.Grigor'ev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 794-99 (Sept., 1960). In Russian.

An infinite set of "chain" equations relating the matrices of various transitions is written down. Mass renormalization is performed. The renormalized set is used to treat multiple creation of bosons in collisions of two fermions. [English translation in: Soviet Physics–JETP (USA)].

3146 MASS LEVELS OF BARYONS AND MESONS.
S.Sawada and M.Yonezawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 662-93 (April, 1960).

The relation between the observed mass levels of baryons and mesons is studied, as well as the resonance levels in pion–nucleon and kaon–nucleon reactions and the various configurations of particle states derived from Ikeda–Ogawa–Ohnuki's symmetry theory (Abstr. 20053 of 1960) which is based on Sakata's composite-particle model (Abstr. 6884 of 1957). It is found that there is a close correspondence between the theoretical levels and the experimental evidence.

3147 A CONTRIBUTION TO THE ANOMALOUS MAGNETIC MOMENTS OF THE BARYONS.
T.T.Crow and W.G.Holladay.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 164-7 (Jan., 1961).

A method of calculation and results are presented for the fourth-order one-pion, one-kaon contribution to the magnetic moments of the baryons. Static, charge-independent interactions of spin-$\frac{1}{2}$ baryons with pseudoscalar kaons are assumed. For this calculation a renormalization programme is formulated similar to that of Chew but in which the baryon mass differences are taken into account. In general, the contributions calculated are comparable to second-order kaon contributions. Therefore, it would appear that more accurate and elaborate computations of these moments should incorporate combined effects of the pion and kaon fields.

3148 DIPOLE MOMENT OF UNSTABLE ELEMENTARY PARTICLES. Ya.B.Zel'dovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11) 1483-5 (Nov., 1960). In Russian.

It is pointed out that, although T invariance in general forbids the occurrence of a dipole moment due to the virtual decay of a neutral into two charged elementary particles, if the neutral particle is unstable against decay into two other neutral particles, the resulting complex mass can give rise to a non-zero dipole moment due to the virtual charged decay if this violates parity. [English translation in: Soviet Physics - JETP (USA)].
R.F.Peierls

3149 IN CONNECTION WITH THE ARTICLE BY L.G.YAKOVLEV "CALCULATION OF PHASE SPACE INTEGRALS IN THE COVARIANT FORMULATION OF THE THEORY OF MULTIPLE PRODUCTION OF PARTICLES". G.I.Kopylov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 209 (July, 1960). In Russian.

It is claimed that the article in question (Abstr. 11116 of 1960) contains errors in the evaluation of the phase space integrals, owing to a failure to take correctly into account the conservation of energy and momentum, the integrals being in fact extended to unphysical regions. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 1, 150 (Jan., 1961)].
R.F.Peierls

3150 COVARIANT STATISTICAL THEORIES OF MULTIPLE PARTICLE PRODUCTION.
V.M.Maksimenko and I.L.Rozental'.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 754-6 (Sept., 1960). In Russian.

Possible covariant theories of multiple particle production are analysed under the condition that the matrix element can be factorized. The multiplicity of secondary particles is computed by assuming that the matrix element is a power function of the energy of particles involved in the process. [English translation in: Soviet Physics–JETP (USA)].

Photons

3151 ANGULAR CORRELATION OF GAMMA QUANTA FROM ELECTRON–POSITRON ANNIHILATION IN BISMUTH. I.Ya.Dekhtyar and V.S.Mikhalenkov.
Dokl. Akad. Nauk SSSR, Vol. 133, No. 1, 60-3 (July 1, 1960). In Russian.

For abstract, see Abstr. 2046 of 1961. [English translation in Soviet Physics–Doklady (USA), Vol. 5, No. 4, 739-42 (Jan.-Feb., 1961)].

3152 EFFECT OF MULTIPLE SCATTERING ON TRANSIENT RADIATION. V.E.Pafomov.
Dokl. Akad. Nauk SSSR, Vol. 133, No. 6, 1315-18 (Aug. 21, 1960). In Russian.

For abstract, see Abstr. 2037 of 1961. [English translation in Soviet Physics–Doklady (USA), Vol. 5, No. 4, 850-2 (Jan.-Feb., 1961)].

3153 DESIGN OF A GAMMA-RAY SPECTROMETER USING THE PHOSWITCH TECHNIQUE FOR REJECTION OF CHARGED PARTICLES. F.C.Jones.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 175-7 (June-Sept. 1960). [Proceedings of the Seventh Scintillation Counter Symposium Washington, February, 1960].

The "phoswitch" technique may be used to construct a gamma-ray spectrometer that will not respond to charged particles. The theory and design of such a device are discussed and some preliminary data on its performance are presented.

3154 A SILICON γ RAY SPECTROMETER.
P.E.Gibbons and D.C.Northrop.
Nature (GB), Vol. 188, 803 (Dec. 3, 1960).

Samples of 5000 ohm cm p-type silicon at room temperature gave detectable current pulses when exposed to 1 MeV γ-radiation or 4 MeV α-radiation. When the sample was cooled to liquid-air temperature the signal-to-noise ratio for γ-radiation from Co^{60} was greater than 50 to 1, and the pulses were as large as 2 mV. These detectors offer possibilities for high-resolution spectroscopy.
C.Hilsum

3155 PASSAGE OF γ-RAYS THROUGH A COLLIMATOR.
N.Dubinskaya and U.Ulmanis.
Latv. PSR Zinat. Akad. Vestis (USSR), No. 4(153), 99-104 (1960). In Russian.

Gives a simple theoretical treatment of the fraction of γ-radiation transmitted by a cylindrical collimating slit, with an allowance for geometrical attenuation and transmission through the edges of the slit. An experimental check is largely inconclusive, the differences between the theoretical predictions and the experimental results being attributed to the finite sizes of a source and a detector.
J.E.Gor

3156 BREMSSTRAHLUNG IN HIGH DENSITY MEDIA AT HIGH ENERGIES. Y.H.Ichikawa and M.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 81-6 (Jan., 1960).

Qualitative discussions are presented concerning the effects of the collective motion of media for the bremsstrahlung process in high density at high energies. The formula derived for the bremsstrahlung cross-section has similar structure to the Nozières–Pines' cross-section for Compton scattering, obtained by taking into account effects of the collective motion of electrons.

3157 CYCLOTRON RADIATION FROM RELATIVISTIC PARTICLES WITH AN ARBITRARY VELOCITY DISTRIBUTION. L.Oster.
Phys. Rev. (USA), Vol. 121, No. 4, 961-7 (Feb. 15, 1961).

For previous work, see Abstr. 15316 of 1960. A formula is derived which represents the spectral and angular behaviour of cyclotron radiation emitted by a relativistic particle moving in a constant magnetic field and having arbitrary velocity components parallel and perpendicular to the field. This formula is used to describe the emission of an assembly of particles having a Maxwellian distribution function. All broadening mechanisms of practical importance — collisions, relativistic mass variability and Doppler effects — are included and discussed.

3158 [ELECTROMAGNETIC] RADIATION FROM A PARTICLE MOVING ACROSS THE INTERFACE OF TWO MEDIA ALLOWING FOR THE EFFECT OF MULTIPLE SCATTERING.
G.M.Garibyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 332-6 (Aug., 1960). In Russian.

The spectral distribution of the radiation intensity is derived. [English translation in: Soviet Physics—JETP(USA), Vol. 12, No. 2, 237-9 (Feb., 1961)].

3159 CERTAIN THEORETICAL ASPECTS OF RADIATION DUE TO SUPERLUMINAL MOTION IN A MEDIUM.
V.L.Ginzburg.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 4, 537-64 (Dec., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 6, 874-93 (June, 1960).

The article reviews several topics connected with Cherenkov radiation. The general theory of such radiation is considered and applied to the radiation and absorption of waves in an isotropic magnetoactive plasma, and also to the discussion of Cherenkov radiation of dipole moments in a continuous medium and in channels and slits. R.F.Peierls

Neutrinos

3160 NEUTRINOS IN THEORY AND EXPERIMENT.
S.Devons.
Sci. Progr. (GB), Vol. 48, 675-83 (Oct., 1960).

Non-specialist review describing the development of the main ideas about the neutrino, from Pauli's hypothesis and Fermi's first theories, to the discovery of the helicity of the neutrino, modern ideas on the universal Fermi interaction, and possible future experiments to detect high-energy neutrino interactions. J.C.Taylor

3161 NEUTRAL LEPTON CURRENTS AND NEUTRINO DETECTION. R.W.King.
Phys. Rev. (USA), Vol. 121, No. 4, 1201 (Feb. 15, 1961).

The interactions of neutrinos with complex nuclei are explored assuming the existence of a neutral lepton current.

NEUTRINO EMISSION FROM BLACK-BODY RADIATION AT HIGH STELLAR TEMPERATURES. See Abstr. 2636

3162 INTERACTIONS INDUCED BY HIGH ENERGY NEUTRINOS. Y.Yamaguchi.
Progr. theor. Phys. (Japan), Vol. 33, No. 6, 1117-37 (June, 1960).

High energy neutrino—electron and neutrino—nucleon collisions are discussed. In particular the "elastic" processes $\bar{\nu} + p \rightarrow n + e^+$ and $\nu + n \rightarrow p + e^-$ are investigated in detail. The cross-section of $\nu + n \rightarrow p + e^-$ is estimated to be $\sim 0.8 \times 10^{-38}$ cm^2 for neutrino energy in the lab. system of > 1 BeV under reasonable assumptions.

Electrons

3163 DETERMINATION OF VELOCITY DISTRIBUTION OF ELECTRONS FROM OBSERVED SPECTRAL DISTRIBUTION OF BREMSSTRAHLUNG.
M.S.Sodha, C.E.Stewart and R.F.Tooper.
Progr. theor. Phys. (Japan), Vol. 22, No. 3, 461-3 (Sept., 1959).

A solution is given of the integral equation for spectral distribution of emission bremsstrahlung from an ionized gas in the range of validity of Born approximation for the distribution function of electron velocities. It is thus shown that the electron velocity distribution in an ionized gas can be obtained from a knowledge of spectral distribution of emission bremsstrahlung per unit volume, which, in turn, can be determined from the observation of emission from the surface of an ionized gas. M.S.Sodha

3164 ON A NON-LOCAL ELECTROMAGNETIC MODEL FOR ELECTRON AND MUON MASSES.
J.Leal Ferreira and Y.Katayama.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 776-86 (May, 1960).

A non-local electromagnetic interaction with a Pauli term is assumed in order to explain phenomenologically the whole masses of the electron and muon. The properties of form factors are discussed qualitatively on the assumption of similar internal structures for both particles.

3165 SCATTERING OF HIGH-ENERGY ELECTRONS BY PROTONS.
R.R.Wilson, K.Berkelman, J.M.Cassels and D.N.Olson.
Nature (GB), Vol. 188, 94-7 (Oct. 8, 1960).

Experiments performed with the Cornell synchrotron at scattering angles of 66° and 112° with momentum-transfers ranging up to 5 f^{-1} ($q^2 = 25\ f^{-2}$) confirm the Stanford data (Abstr. 573 of 1959; 17305 of 1960) in the range in which they overlap. However, the results at the smaller angle demonstrate that for $q^2 > 5\ f^{-2}$, the charge form factor must be appreciably larger than the magnetic form factor. [The same conclusion has been reached by Hofstadter, Bumiller and Croissiaux (Abstr. 3178 of 1961), who determined the individual form factors with higher accuracy]. P.K.Kabir

3166 SEMICONDUCTOR ELECTRON DETECTORS.
J.M.McKenzie and G.T.Ewan.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 50-4 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

The properties of p-n junctions made by phosphorus diffusion in 12000 ohm cm p-type silicon were examined using the Chalk River β-ray spectrometer as a source of monoenergetic electrons. With 200 V reverse bias the depletion layer is thick enough to absorb totally 350 keV electrons. Up to 1200 keV some of the electrons are scattered sufficiently to deposit all their energy in the junction. This results in a total absorption peak up to electron energies of 1.2 MeV. However, at this energy most of the electrons act like minimum ionizing particles and deposit 180 keV of energy in the junction.

Nucleons

3167 ON THE ELECTROMAGNETIC STRUCTURE OF NUCLEONS AND THEIR MASS DIFFERENCE.
Y.Katayama, M.Taketani, S.Ragusa and D.R.de Oliveira.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 328-52 (Feb., 1960).

A semi-phenomenological method is proposed for the study of the structures of elementary particles, based on the problem of the electromagnetic structure of the nucleon. The analyses of structure are separated into two parts. One is the analysis of the outer structure which is characterized as the quasi short distance and defined by $r \sim 0.5$ y, using the units of $\hbar = c = 1$. Though present field theory could be applied in this region, it is shown that the shape-independent feature also holds in so far as the present experimental information is concerned. The other part of the analysis is the assumption of the inner structure of the extreme short distance. A physical quantity can be derived which is effective in the analysis of this region by using a proposed trial model in agreement with present experiments. A further assumption is derived from the electromagnetic mass difference of the nucleons. The analyses are devoted to three effects: (a) effect of the change of the form factors at the extreme short distance; (b) effect of the neutron charge form factor, and (c) effect of the higher-order corrections of the strong interactions. These effects explain the mass difference qualitatively. A small modification of the inner structure gives quantitative agreement with the experimental value. Problems remaining to be solved are discussed.

3168 BOUND STATES IN FOUR NUCLEON COUPLING.
H.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1100-16 (June, 1960).

An interaction Lagrangian of general four-nucleon coupling is assumed and equations for nucleon—antinucleon and two-nucleon systems in three types of chain approximation are derived from the interaction and solved exactly. The mathematical structure of the solutions is then studied in various cases, and the regions where the value of the coupling constant must lie in order to give the bound states are obtained in the case of pseudoscalar coupling. Some interesting features are pointed out.

3169 THE NUCLEON—NUCLEON POTENTIAL.
A.F.Grashin and Yu.P.Nikitin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 713-19 (Sept., 1960). In Russian.

A convenient method is proposed for setting up the potential in the form of the series $U(x) = \Sigma U^{(n)}(x)$, where $U^{(n)}(x) \sim e^{-nx}$ for $x \rightarrow \infty$, using the meson-theoretical scattering amplitude expressed

as an expansion in the exchange mesons (x is the distance in $1/\mu$ units and μ is the meson mass). In the case of peripheral nucleon interaction the application of this method yields a two-meson potential with a broad locality region $p^2/m^2 \ll 1$ (non-relativistic region). The two-meson potential consists practically of tensor and central attractive forces which weakly depend on the isotopic state. [English translation in: Soviet Physics–JETP (USA)].

3170 IMPACT PARAMETER AND PERTURBATION TREATMENT OF THE DISTANT COLLISION OF NUCLEONS WITH PION EMISSION.
H.Ezawa, O.Kamei, K.Mori, H.Shimoida and T.Yoneyama.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p.274-84

The purpose of this paper is to introduce certain proposals (the use of an impact parameter and the application of the perturbation method) in an attempt to overcome two major difficulties inherent in the present models of multiple meson production: the variety of events and the consequent poor statistics and the obscurity of the theoretical basis of the models. C.F.Barnaby

3171 FOUR-NUCLEON REACTIONS WITH CENTRAL FORCES. P.G.Burke and W.Laskar.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 49-58 (Jan., 1961).

The four-nucleon reaction is formulated using the resonating group method and including the three groupings dd, nHe^3, and pt. The central potential used is of Gaussian shape with exchange dependence (Serber and symmetrical exchange have been mainly investigated). The wave-functions for the nuclear ground states are double Gaussian for deuterons and single Gaussian for t and He^3, the parameter being determined by variational methods to fit the binding energies. Coupled integro-differential equations are derived for each value of the total spin and angular momentum of the corresponding system. Preliminary results are obtained by including only one channel for dd and are given here.

3172 TWO-NUCLEON POTENTIAL WITH THE "ONE-PION-EXCHANGE TAIL". II.
T.Hamada, J.Iwadare, S.Otsuki, R.Tamagaki and W.Watari.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 366-71 (Feb., 1960).

For Pt I, see Abstr. 20072 of 1960. The p–p scattering below 100 MeV is analysed on the basis of a static potential with the "one-pion-exchange tail" previously proposed from an analysis around 100 MeV. This potential can reproduce all available data in this energy range quite satisfactorily. Some discussions on the depolarization parameter are given.

3173 NUCLEON STRUCTURE AND BeV INTERACTIONS. D.Ito.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 752-4 (April, 1960).

Negative pion–proton scattering at 1.4 BeV is fitted by a semi-classical formula, assuming that the nucleus is a purely absorbing well of exponential or Gaussian form factor. The mean square radius is set at 0.8 fermis and the depth adjusted to the total inelastic scattering. The exponential form gives a better fit.
D.W.L.Sprung

3174 DISPERSION RELATIONS IN NUCLEON–NUCLEON SCATTERING. Y.Hara and H.Miyazawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 942-56 (May, 1960).

The two-pion contribution to the absorptive part of nucleon–nucleon scattering amplitudes in the unphysical region is calculated using the dispersion relations for pion–nucleon scattering. The dispersion relations with this absorptive part are used for analysing nucleon–nucleon scattering data at low energy and at moderate energy; good agreement is found if the coupling constant is chosen as $f^2/4\pi = 0.08 \pm 0.01$.

3175 POLARIZED NUCLEONS. I. POLARIZATION BY SCATTERING. H.Faissner.
Ergeb. exakt. Naturwiss. (Germany), Vol. 32, 180-346 (1959). In German.

Review article. Phenomenological description of polarization; Quantum-mechanical description of polarization; Phenomenological description of polarization by scattering; Triple-scattering and correlation experiments; Quantum-mechanical treatment of scattering by the nucleus with spin zero; Scattering by nuclei with optional spin; Effective mechanisms; Experiments and scattering-phase analyses at low energies; Experiments at high energies; Scattering by complex nuclei; Nucleon–nucleon scattering.

3176 $N\bar{N} \leftrightarrow \pi\pi$ AMPLITUDE AND THE ELECTROMAGNETIC STRUCTURE OF THE NUCLEON.
J.S.Ball and D.Y.Wong.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 29-31 (Jan. 1, 1961).

The Frazer–Fulco calculation (Abstr. 7341, 7404 of 1960), of this amplitude is improved by (a) using a subtracted dispersion relation in which use is made of the fact that the $N\bar{N}$ to $\pi\pi$ amplitude at zero total energy is identical to the forward πN scattering amplitude, and (b) representing the $\pi\pi$ interaction by a "two-pole" P-wave effective range formula. To fit the nucleon magnetic moment, it is necessary to choose a value for the residue at one of the poles which is too large to satisfy the Chew–Mandelstam crossing relations, indicating either that the effective-range form is inadequate or that higher mass intermediate states must be take into consideration. P.K.Kab

Protons

3177 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. IV. CHARGE DISTRIBUTION OF THE PROTON. K.Hiida, N.Nakanishi and T.Shiozaki.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1189-1203 (June, 1960)

For Pt III, see Abstr. 20118 of 1960. It is suggested from experimental data and theoretical analyses that the charge distribution functions of the proton will become negative in the inner region. The Stanford data on electron–proton scattering is re-examined, and a lower bound for $\langle r^2 \rangle_{1,p}$ is given independently of the model from some general assumptions. As examples, two tria proton models are considered which are consistent with the prese Stanford data and in which the values of $\langle r^2 \rangle_{1,p}$ are rather smaller than the usually accepted ones.

3178 SPLITTING OF THE PROTON FORM FACTORS AND DIFFRACTION IN THE PROTON.
R.Hofstadter, F.Bumiller and M.Croissiaux.
Phys. Rev. Letters (USA), Vol. 5, No. 6, 263-5 (Sept. 15, 1960).

Recent measurements on electron–proton scattering (Abstr. 2039 of 1961) have extended measurements of the proton form factors (F_1,F_2) to regions of momentum transfer $9.3 < q^2 < 21.24$ where q^2 is measured in $(\text{fermis})^{-2}$. The form factors are less than unity, indicating finite structure and remain almost equal up to $q^2 \cong 7$ when they diverge, F_1 tending to become constant at a value 0.43 and F_2 tending to zero at $q^2 \sim 24$. This tendency of F_2 indicates that the Pauli magnetic moment cloud of the proton has a spread-out distribution and the F_1 value suggests that the Dirac electron magnetic cloud has a small core. The electron–proton scattering data at 145° shows a characteristic diffraction dip similar to that observed in electron scattering studies with heavie nuclei. R.E.Mea

3179 ON THE CHARGE DISTRIBUTION OF THE PROTON. K.Hiida, N.Nakanishi and T.Shiozaki.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 192-4 (Jan., 1960).

To investigate an apparent discrepancy between the prediction of meson theory and experiment, the data for the mean square rad of charge and a.m.m. of the nucleon are reanalysed assuming $\langle r^2 \rangle_1^S \cong \langle r^2 \rangle_1^V$, but not that $F_1 = F_2$. The proton's charge distributio is assumed to be peaked negative at $r < \sim 0.5$ and peaked positive au $r > \sim 1.5$; its a.m.m. distribution and the isovector part are taken to be positive definite. The resulting F_1–F_2 diagram is similar to thi of Karplus [Kiev Conference, 1959]. The authors claim that, with these assumptions, a simple model can be constructed in which the Stanford data yield results in better agreement with meson-theore calculations. I.J.R.Aitchis

3180 ON THE POSSIBLE EXISTENCE OF ELECTRIC DIPOLE MOMENTS OF THE PROTON AND THE ELECTRON. H.Narumi and S.Matsuo.
Doshisha Engng Rev. (Japan), Vol. 10, No. 3-4, 89-95 (Dec., 1959). In Japanese.

By assuming the possible existence of electric dipole moment of the proton and the electron, in connection with the PT non-invariance problem of electromagnetic interactions, the authors derive a correction formula concerning the hyperfine structure of hydrogen, whose experimental uncertainty leads to an upper limit to these dipole moments. The values obtained are compared with the results derived from the Lamb shift.

3181 DEPENDENCE OF p–p SCATTERING PARAMETERS ON PHASE SHIFTS. B.P.Nigam.
'rogr. theor. Phys. (Japan), Vol. 23, No. 1, 61-75 (Jan., 1960).

An attempt is made to discuss the dependence of the double and riple p–p scattering parameters on the $^1S_0$, $^1D_2$, $^3P_{0,1,2}$, $^3F_2$ phase hifts with special reference to the SM1 potential at 150 MeV. It s found that a positive depolarization requires a small or even egative $^3P_0$ phase shift thus favouring a strong spin–orbit poten- ial. The parameters R and A depend chiefly on the $^1S_0$ and $^1D_2$ hase shifts.

3182 ASYMMETRY IN 143 MeV pn SCATTERING. A.F.Kuckes and R.Wilson.
'hys. Rev. (USA), Vol. 121, No. 4, 1226-8 (Feb. 15, 1961).

A beam of 145 MeV protons of polarization 69 ± 2% was scat- ered from liquid deuterium. p–n scattering events were identified y a coincidence method. The asymmetry in the scattering was neasured. These data can be compared with polarization in free n–p scattering at the appropriate angles.

3183 ELASTIC SCATTERING OF 146 MeV POLARIZED PROTONS BY DEUTERONS. H.Postma and R.Wilson.
'hys. Rev. (USA), Vol. 121, No. 4, 1229-44 (Feb. 15, 1961).

The polarization and differential cross-section of 146 MeV rotons elastically scattered by deuterons were measured in the entre-of-mass angular range from 3.9° to 170°. The liquid deuter- um target and detection apparatus which permitted the measurement f the elastic events over these angles are described. At small ngles the proton was energy-analysed; at large angles the recoil artner of the proton, the deuteron, was identified and energy- nalysed. Although the energy resolution of ±1.7 MeV and the ngular resolution of ±2.0° were sufficient to separate quasi-elastic vents from elastic events at most angles, they were insufficient to esolve unambiguously the 2.3 MeV inelastic events resulting from he formation of virtual deuterons. The measured cross-section is n qualtitative agreement with cross-sections at neighbouring nergies; no comparison of measured polarizations is possible due o the lack of other experiments. The cross-sections and polariza- ion for angles less than 80° c.m. are well fitted by the Kerman, McManus, and Thaler theory (Abstr. 5739, 7256 of 1959) using the Jammel and Thaler nucleon–nucleon potential description. The nergy and angular dependence of the large-angle pickup cross- section proposed by Chew and Goldberger (Abstr. 4347 of 1950) agree well with experiment; however, the small measured positive polar- zation is not predicted by this theory, and probably indicates destruc- ive interference between the direct and the pickup scattering.

3184 A NOTE ON THE POLARIZATIONS FOR p–He^3 AND p–T^3 SCATTERING. Y.Sakamoto and T.Takemiya.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 190-2 (Jan., 1960).

A calculation using the impulse approximation, and neglecting the d-states of He^3 and T^3, shows that the polarization in p–He^3 scattering is greater than that in p–T^3. This is related to the differ- ing contributions to the spin-flip and non-spin-flip amplitudes in the two cases. The results suggest that measurements of the p–He^3 and p–T^3 polarizations could distinguish between the S-M and G-T phase shifts at 180 MeV. I.J.R.Aitchison

3185 TOTAL CROSS-SECTIONS OF PROTONS WITH MOMENTUM BETWEEN 10 AND 28 GeV/c.
A.Ashmore, G.Cocconi, A.N.Diddens and A.M.Wetherell.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 576-8 (Dec. 15, 1960).

The p–p total cross-section was measured at eight momentum values, and the p–n at three, by a good-geometry transmission method. The incident beam was produced by scattering at a small angle (25 mrad) from an internal Al target in the CERN proton synchrotron, and the elastic peak magnetically isolated. CH_2/C and D_2O/H_2O ratios were used. The p–n and n–p cross-sections were almost constant over the momentum range, being 39 and 36 mb respectively. Measurements were also made of the absorption cross-sections of the elements at 24.2 GeV/c, and gave transparencies in agreement with the measured nucleon–nucleon cross-sections. A.Ashmore

3186 RANGE OF PROTON–ANTIPROTON ANNIHILATION. M.Lévy.
Phys. Rev. Letters (USA), Vol. 5, No. 8, 380-1 (Oct. 15, 1960).

The "maximum theorem" of Rarita and Schwed (Abstr. 1084 of 1959) is generalized for the case when the absorptive region is surrounded by an attractive potential. The result, valid to first order in V, is

$$(\sigma_{tot})^2/\sigma_{el} \cong 4\pi R^2(1 + \frac{|V|}{E})$$

The antiproton cross-sections in the energy range from 200 MeV to 2 BeV "can be fitted quite well by taking $R = 1.43 \times 10^{-13}$ cm and $|V| \cong 38$ MeV." If pion production without annihilation is the dominant inelastic process, this is quite a reasonable result; however, if the main contribution is from annihilation, the long range of the annihilation region remains a puzzle. P.K.Kabir

3187 APPARATUS DRAWINGS PROJECT: REPORT NUMBER 14. OMEGATRON FOR UNDERGRADUATE LABORATORY DETERMINATION OF THE RATIO e/m OF THE PROTON. R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 2, 90-4 (Feb., 1961).

An omegatron, a form of cyclotron, designed for measuring the cyclotron resonance frequency of light positive ions, is described. Protons, formed by the collision of electrons and residual gas molecules in the apparatus, are accelerated normal to the axis of two semicylindrical electrodes by an r.f. electric field. An intense uniform magnetic field, parallel to the electrode axis, causes the protons to follow spiral paths. When the frequency of the electric field is approximately 5 Mc/s, the magnetic field required is about 4 kG, uniform over a volume measuring 2.5 cm diameter × × 3 cm. From data obtained with this instrument, the student can compute the ratio e/m of the proton. The agreement between this computed value and the accepted modern value for e/m of the proton, is directly dependent upon the accuracy with which frequency and magnetic field strength can be measured.

3188 PROTON–ANTIPROTON ANNIHILATION AND NUCLEON STRUCTURE. S.Minami.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 194-6 (Jan., 1960).

The average pion multiplicity is calculated, neglecting the kinetic energies of p and $\bar{p}$, and assuming that: (a) the mean momentum of the observed pions is inversely proportional to the mean of $\frac{1}{2}(r + r')$, where r and r' are the distances of the annihilation event from the centre of the proton and antiproton respectively, and (b) the proton's charge distribution function $\rho(r)$ may be regarded as an expression of the probability amplitude for a π–N collision at the point r. Agreement with experiment is satisfactory for three forms of ρ. The mean energy $\langle\epsilon\rangle$ of emitted pions is found to be 380 MeV, and the author suggests that the maxima at 0.9 and 1.4 BeV in the π–N cross-sections may be explained by a similar mechanism, in which a number of pions of energy $\langle\epsilon\rangle$ are produced. It is also pointed out that the impact parameter responsible for the (3, 3) resonance in π–N scattering at 190 MeV is nearly equal to the mean radius of the charge distribution. These facts are taken to indicate that nucleon structure may help to explain pion phenomena at high energies. I.J.R.Aitchison

Neutrons

3189 AN ITERATIVE METHOD FOR NEUTRON TRANSPORT PROBLEMS WITH SPHERICAL SYMMETRY.
W.R.Conkie.
Canad. J. Phys., Vol. 39, No. 2, 295-314 (Feb., 1961).

An iterative method developed previously for transport problems with plane symmetry has been extended to problems with spherical symmetry. Particular application has been made to the problem of the neutron distribution for a black sphere embedded in a purely scattering medium with sources at infinity. The results compare favourably with those of other workers for this problem.

3190 ELEMENTARY INTRODUCTION TO THE STUDY OF THE TIME-DEPENDENT MATERIAL BUCKLING.
A.Y.Ozenore.
Nukleonik (Germany), Vol. 2, No. 5, 213-14 (Sept., 1960). In French.

The time dependence of the material buckling of a multiplying core is studied in connection with the time variation of the macroscopic fission and absorption cross-sections, taking into account the effect of the delayed neutrons. In order to keep the reactor critical the absorption in the core would have to be changed, and this variation in core absorption is determined. J.F.Hill

3191 AGE IN D_2O–H_2O MIXTURES. W.H.Arnold, Jr.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 456-7 (Nov., 1959).
Measurement of the age to indium resonance in various mixtures of D_2O and H_2O are compared with calculated values using the MUFT 4 code modified to include the term $\partial\lambda/\partial u$ in the Grueling–Goertzel–Amster approximation. Very good agreement is found. J.F.Hill

3192 THE SPATIAL DEPENDENCE OF NEUTRON TEMPERATURE IN MODERATORS. T.Springer.
Nukleonik (Germany), Vol. 2, No. 4, 144-9 (June, 1960).
In German.
Analysis of the problem of neutron temperature distribution in a moderator with homogeneous neutron sources in the neighbourhood of a strongly absorbing large plate. C.G.Morgan

3193 THE USE OF SURFACE-BARRIER DIODES FOR FAST-NEUTRON SPECTROSCOPY.
T.A.Love and R.B.Murray.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 91-102 (Jan., 1960).
[Proceedings of the Seventh Annual National Meetings. Solid State Radiation Detectors].
The construction and performance of surface-barrier detectors are described. Experimental pulse-height spectra are presented and discussed.

3194 A FAST-NEUTRON SPECTROMETER. L.F.Kondrashev, A.A.Kurashov, A.F.Linev, V.A.Sidorov, N.I.Sokolov and N.N.Khaldin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 17-21 (Jan.-Feb.).
In Russian.
A description is given of a telescope arrangement with four proportional counters and a thin polyethylene radiator, which is used to measure the spectra and fluxes of neutrons produced at the target of a 150 cm cyclotron. Remote control devices are used to vary the arrangement of radiators and aluminium filters which slow down the recoil protons. The spectrometer was used to study the reaction $T(p, n)He^3$ up to proton energy 12 MeV. [English translation in: Instrum. exper. Tech. (USA), No. 1, 16-20 (Jan.-Feb., 1958; publ. April, 1959)].

3195 ON THE SPATIAL INTEGRATION OF NEUTRON FIELDS WITH MOVING NEUTRON DETECTORS.
W.Hage.
Nukleonik (Germany), Vol. 2, No. 2, 73-9 (April, 1960). In German.
The equations are derived which describe the motion of probes or counters, that will result in activations or numbers of counts which are proportional to the amplitude of eigenfunctions or the mean values of the neutron flux in media with plane, cylindrical or spherical geometry. The application of this method to the measurement of the migration length in infinite media, and of the flux curvature in a cylindrical medium with fast monoenergic sources, is discussed. D.H.Lord

3196 RADIATION SHIELDING MEASUREMENTS IN MIXED NEUTRON FIELDS WITH PARAFFIN MODERATORS.
W.Pohlit and H.Pohlit.
Nukleonik (Germany), Vol. 2, No. 5, 175-8 (Sept., 1960). In German.
By surrounding a BF_3 counter with a moderator it is possible to measure the flux density and dose power and to estimate the mean neutron energy of a fast neutron field. The calculations of the flux density variations with moderator thickness and initial neutron energy are reviewed. Investigations of several types of moderator geometry are described. D.H.Lord

Mesons

3197 POSSIBILITY FOR OR AGAINST THE EXISTENCE OF A NEUTRAL SCALAR MESON. K.Igi.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 170-2 (Jan., 1960).
The existence of such a particle would lead to a pole in the angular distribution in π^-–p elastic scattering. The extrapolation is attempted for an assumed mass, using data for 270 MeV pions, but no evidence found. The coupling to pions is estimated and found to be small. D.W.L.Sprung

3198 THE PSEUDOVECTOR CURRENT AND LEPTON DECAYS OF BARYONS AND MESONS.
Chzhou Guan-Chzhao [Chou Kuang-chao].
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 703-12 (Sept., 19
In Russian.
Using the analytic properties of a certain matrix element it i shown that the result obtained by Goldberger and Treiman (Abstr. 5224 of 1958) concerning the decay $\pi \rightarrow \mu + \nu$ is valid for more extensive classes of strong interactions than those found by Feynman, Gell-Mann and Levy and, in particular, for the usual pseudoscalar theory of pseudoscalar coupling. A formula is dedu which can be employed to verify experimentally the assumptions made. Hyperon and K-meson lepton decays are also discussed. [English translation in: Soviet Physics–JETP (USA)].

3199 CHANGE OF PROBABILITY OF FAST MESON DECA CAUSED BY COULOMB SCATTERING IN DENSE MEE
M.I.Ryasanov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abst 7427 of 1960) Vol. II, p. 328-9.
If a fast charged meson decays in a condensed medium, some energy may be transferred to the atoms of the medium by Coulom scattering. The disturbance of the kinematics of the decay and th change in the probability of the decay resulting from this effect is considered. C.F.Barna

3200 MULTIPLE PRODUCTION OF MESONS IN PION–NUCLEON COLLISIONS. W.Czyż and S.L.Glashow.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 309-12 (Oct. 4, 1960).
The model of Czyz, Ericson and Glashow for multiple meson production in energetic nucleon–nucleon collisions is applied to t analogous pion–nucleon process. The angular distributions of th shower particles of such events are predicted to display a single-cone structure, and to be forward peaked in the centre-of-mass system at primary energies greater than 400 GeV. The model should be applicable for pion energies beyond 50 GeV.

3201 REMARKS ON THE ENERGY DISTRIBUTION OF MESONS CREATED IN HIGH-ENERGY NUCLEAR COLLISIONS. E.M.Friedländer.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 220-4 (Nov. (5), 1960).
It is shown that the assumption of a Heisenberg-type spectru for the secondaries from high-energy meson jets is in contradictio with the observed distribution of c.m.s. angles and that of the transverse momenta. Starting from observational data on the latter quantities a rough approximation for the c.m.s. energy spectrum is computed.

3202 OBSERVATION OF THE HYPERFINE STRUCTURE SPLITTING OF MUONIUM BY USE OF A STATIC MAGNETIC FIELD. R.Prepost, V.W.Hughes and K.Ziock.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 19-21 (Jan. 1, 1961).
Positive muons from the Nevis synchrocyclotron were stoppe in a gas target of argon at 55 atm, placed in a longitudinal magnet field. Decay positrons were counted in the forward direction for fields between 100 and 5800 G. The results are consistent with muonium formation by all stopping muons, and a hyperfine structu splitting of 4500 Mc/s (limits 2250 and 9000 Mc/s). A.Ashmo

3203 RADIATIVE CORRECTIONS TO THE SCATTERING O μ-MESONS ON ELECTRONS. A.I.Nikishov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 757-66 (Sept., 196
In Russian.
Formulae giving the cross-sections of the processes $\mu + e^{\pm} \rightarrow \mu + e^{\pm}$ and $e^+ + e^- \rightarrow \mu^+ + \mu^-$ are deduced with an accura to e^6. [English translation in: Soviet Physics–JETP (USA)].

SHELL MODEL CALCULATIONS OF THE HYPERFINE EFFE IN μ-MESON CAPTURE. See Abstr. 3528

3204 NEW EXPERIMENTAL DATA ON π- AND μ-MESON DECAYS. O.A.Vaisenberg.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 3, 429-87 (March, 1960).
In Russian. English translation in: Soviet Physics - Uspekhi (USA), Vol. 3, No. 2, 195-229 (Sept.-Oct., 1960).
Review of experiments during two years ending March 1960. 144 references. E.J.Burg

3205 ELECTROMAGNETIC MESON MASS DIFFERENCES. D.J.Hall.
ys. Rev. Letters (USA), Vol. 6, No. 1, 31-3 (Jan. 1, 1961).
If the divergent two-photon vertex term is eliminated by working a gauge in which it is identically zero, the remaining term comes finite in the "pole" approximation to the dispersion relation d "a rather satisfactory quantum theory of both the pion and the -meson mass splitting is obtained, in terms of physically reasonple electromagnetic form factors". P.K.Kabir

3206 A FIELD THEORETICAL INVESTIGATION OF MULTIPLE MESON PRODUCTION. I. PION–UCLEON COLLISIONS. K.Kobayakawa and T.Imamura.
ogr. theor. Phys. (Japan), Vol. 23, No. 1, 137-60 (Jan., 1960).
By introduction of the interaction time and assuming that the free amiltonian can be approximately put as a C-number during the lculation of the effect due to the interaction Hamiltonian for the teraction time-interval, it is shown that multiple meson produc- on is caused by the pseudoscalar type interaction. Numerical sults are obtained for the relative cross-sections of n pion oduction, the angular distribution, the momentum distribution of al nucleons, etc. These results are compared with the experi- ental data in BeV and cosmic-ray energy regions. The covariant ase space integration is carried out by the saddle point method d its final expression is comparatively simple. The probability stribution of charge states in the statistical theory is derived by approximate formula instead of the tedious combination of lebsh–Gordan coefficients.

3207 POLARIZATION OF THE RECOIL NUCLEON FROM THE PHOTOPRODUCTION OF PION. M.Kawaguchi.
rogr. theor. Phys. (Japan), Vol. 23, No. 6, 984-8 (June, 1960).
The transverse polarization of the recoil proton from $+ p \rightarrow \pi^0 + p$ is estimated for E_γ = 260, 300, 320, 350, and 400 MeV y a phenomenological method. A calculation of the polarization is arried out for unpolarized incident particles, where the contribution om the electric quadrupole radiation in the $p_{3/2}$ state is neglected. ere only the experimental angular distributions of $\gamma + p \rightarrow \pi^0 + p$ nd $\gamma + p \rightarrow \pi^+ + n$, and six phase shifts of the pion–nucleon cattering, are used as known quantities. Six transition amplitudes f the photopion production, corresponding to $s_{1/2}$, $p_{1/2}$, and $p_{3/2}$ final tates with isotopic spin $\frac{1}{2}$ and $\frac{3}{2}$, can be expressed in terms of these nown quanities, after solving six simultaneous quadratic equations. 10 to 20% polarization is theoretically expected over a wide range f angles in the centre-of-mass system. The transition amplitudes btained are reviewed.

3208 THE PHOTOPRODUCTION OF CHARGED PIONS FROM DEUTERIUM. J.G.Rutherglen and J.K.Walker.
roc. Phys. Soc. (GB), Vol. 76, Pt 3, 430-3 (Sept., 1960).
The experiment was made with a liquid deuterium target and a 40 MeV bremsstrahlung beam. Pions at 125° were identified by and dE/dx as well as a delayed muon pulse. The results are in ood agreement with the "adjusted" theory of Moravcsik (Abstr. 729 of 1957). A.Ashmore

3209 DIRECTIONAL CORRELATION OF MESONS IN A CASCADE DECAY OF BARYONS RESULTING FROM A BARYON–BARYON REACTION. A.Deloff and J.Wrzecionko.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 237-44 (Nov. (5), 1960).
This is a continuation of an earlier paper (Abstr. 2017 of 1961). eneral expressions are obtained for the momentum directional orrelation function of mesons resulting from the decay of baryon roducts of a baryon–baryon reaction. A reaction of two unpolarized articles is examined as a special case. Calculations are carried ut assuming that (a) particles before the reaction are in the S-state nly (low-energy zero-threshold collision), or (b) final-state aryons are in the S-state only (high-threshold reaction). Several xperimental possibilities for a determination of the relative ntrinsic parity of baryons are discussed.

3210 TOTAL AND ABSORPTION CROSS SECTION FOR HIGH ENERGY PIONS. C.J.Batty.
roc. Phys. Soc. (GB), Vol. 76, Pt 4, 577-9 (Oct., 1960).
The total and absorption cross-sections for pions on carbon n the energy range 0.6 to 1.2 GeV are calculated from optical- nodel potentials obtained using pion–nucleon scattering amplitudes nd including effects due to the Pauli principle. C.J.Batty

3211 PION–PION RESONANCE IN THE P-STATE. Khé Tszo-Syu [Ho Tso-Hsiu] and Chzhou Guan-Chzhao [Chou Kuang-Chao].
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1485-6 (Nov., 1960). In Russian.
The authors suggest that a study of the reactions $\pi + He^4 \rightarrow He^4 + \pi + \pi$, $\pi + d \rightarrow d + \pi + \pi$, $p + p \rightarrow d + \pi + \pi$, should give information about the T = 1 pion–pion interaction. An assumed resonance in the pion–pion system leads to narrow maxima in the final-state He or d spectra. The process, $d + d \rightarrow He^4 + 3\pi$, would be of interest for the T = 0 interaction. [English translation in: Soviet Physics–JETP (USA)]. D.W.L.Sprung

3212 PION–PION INTERACTION AND PION–NUCLEON SCATTERING. K.Ishida, A.Takahashi and Y.Ueda.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 731-48 (April, 1960).
Pion–pion interaction is analysed using a dispersion relation for pion–nucleon scattering obtained by keeping the momentum transfer between an initial pion and a final nucleon constant. In order to take into account the singularity of the two-pion threshold in the dispersion relation, the dispersion relation may be regarded as an integral equation for pion–nucleon scattering amplitude with the kernel of a pion–pion scattering amplitude. When this solution is compared with experiments on pion–nucleon scattering, it is found that the unknown quantity in the dispersion relation is only a pion–pion scattering amplitude. Therefore, if the pion–pion amplitude is expressed in terms of an unknown parameter such as scattering length, then this value can be determined from the dispersion relation. It is concluded that in the isotopic spin state I = 0 (S-wave) of the pion–pion system, the pion–pion interaction is attractive and the scattering length is of the order of one pion Compton wavelength, while in the isotopic spin state I = 1 (P-wave) of the pion–pion state, a definite conclusion cannot be obtained. The possibility of explaining the momentum dependence of the pion–nucleon phase shift δ_{13} in terms of the pion–pion interaction is briefly discussed.

3213 PION–PION INTERACTION AND PION PRODUCTION IN PION–NUCLEON COLLISION. T.Sakuma.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 810-14 (May, 1960).
Evidence for the $\pi-\pi$ interaction is investigated by considering the angular distribution of nucleons in pion production by pion–nucleon collisions. It is found that it is difficult to understand the sharp forward angular distribution of nucleons without considering a $\pi-\pi$ interaction. The strength of the $\pi-\pi$ interaction is estimated assuming the interaction Lagrangian density $\lambda(\phi_\alpha\phi_\alpha)^2$, the value $|\lambda|/\sqrt{4\pi} \sim 4$ being obtained.

3214 ON MULTIPOLE MODEL OF BARYON–PION INTERACTIONS. K.Fujii and D.Itô.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 815-20 (May, 1960).
A previous model (Abstr. 20051-2 of 1960) is developed in such a way that a quantitative comparison with experimental results is possible. In this model, it is assumed that the baryons correspond to the definite internal states of a nonlocal entity, and the strong and the weak interactions of baryons and pion fields are regarded as their monopole and dipole interactions, respectively. By assuming the internal wave-functions of the extended baryons to be a one-to-one admixture of the symmetric and the antisymmetric parts with respect to the simultaneous reflections both in the isobaric and the Minkowski spaces, the authors show that the weak decay interactions derived from this model are equivalent to the $|\Delta I| = \frac{1}{2}$ global symmetric interactions, which was deduced by d'Espagnat and Prentki (1958) from phenomenological considerations.

3215 PION–NUCLEON INTERACTION, ANOMALOUS MAGNETIC MOMENT OF NUCLEON AND COMPOSITE MODEL FOR PION. C.Ihara.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1035-54 (June, 1960).
The effective pion–nucleon interaction and the anomalous magnetic moment of the nucleon are calculated on the basis of the composite model for the pion, in which the fundamental interaction is assumed to be an adequate linear combination of scalar, tensor and pseudoscalar, or vector and pseudovector Fermi-type couplings. The results are qualitatively in agreement with experiment.

3216 S-WAVE PION-NUCLEON INTERACTION AND NUCLEON CORE. S.Minami.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 519-21 (March, 1960).
Justification of an assumption of a previous letter (Abstr. 20204 of 1960). J.E.Paton

3217 S-WAVE PION-NUCLEON SCATTERING. K.Kawarabayashi and H.Miyazawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 490-5 (March, 1960).
Low-energy S-wave pion—nucleon scattering is investigated with the following two assumptions: (a) dilute nucleon—antinucleon pair extends to a range about $r_0 \cong (2\mu)^{-1}$, μ being a pion mass; (b) a pion—pion interaction with attractive force contributes to the S-wave pion—nucleon scattering. The main characteristics of S-wave pion—nucleon scattering are shown to be reproduced under these assumptions, and the origin of difficulties inherent in S-wave scattering is made clear in terms of potential scattering.

3218 S-WAVE PION—Σ-HYPERON SCATTERING. K.Kawarabayashi and T.Sawada.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 583-96 (April, 1960).
The qualitative character of S-wave $\pi-\Sigma$ scattering is investigated and compared with the corresponding S-wave π—nucleon scattering. Information on S-wave $\pi-\Sigma$ scattering is obtained from K^- capture experiments which suggest large magnitudes of the phase shifts as well as large isotopic spin dependence. It is pointed out that these characteristics seem to be explained only when the doublet approximation proposed by Pais (Abstr. 3704 of 1958) is abandoned. Effects of the K-coupling on S-wave $\pi-\Sigma$ and S-wave K^-—nucleon scattering are also discussed and the result is that the absorption process reflects rather significantly on both scatterings, especially the latter, even when K-meson—baryon couplings are weaker than pion—baryon couplings by an order of magnitude.

3219 S-WAVE PION—NUCLEON INTERACTION. S.Minami.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 887-95 (May, 1960).
Pion—nucleon scattering in the limit of low energy is investigated in order to find some characteristic property of pion—nucleon interaction in the nucleon core. It is pointed out that the value of the coupling constant in the nucleon core ought to be reduced in appearance to $f = (\mu/2M)g$ in spite of the fact that its value in the neighbourhood of the pion cloud is g. Moreover, some attempt to eliminate the divergence included in the dispersion relation is made on the basis of the above result. Experimental results for s-wave phase shifts can be explained satisfactorily.

3220 DETERMINATION OF PION—PION SCATTERING AMPLITUDES SATISFYING DISPERSION RELATIONS AND UNITARITY. J.W.Moffat.
Phys. Rev., Vol. 121, No. 3, 926-32 (Feb. 1, 1961).
A method is developed for determining the partial-wave scattering amplitude in terms of the unitarity condition and the known branch cuts and poles of the inverse amplitude. The method is applied to the problem of pion—pion scattering and an implicit solution to the pion—pion partial-wave amplitude is derived for any angular momentum state and for both elastic and inelastic scattering. With the aid of this solution the low-energy resonance behaviour of the pion—pion scattering system is studied by neglecting all inelastic processes and concentrating on S and P waves. It is found that a P-wave resonance with a position and width required by nucleon electromagnetic structure can be determined in terms of two parameters. An iteration procedure is described that is applicable when the P wave dominates the equations and this procedure determines the contribution of the unphysical cut. The first iteration of the unphysical cut is numerically integrated on the IBM 709, and the results show that the shift of the resonance position due to the unphysical branch cut can be neglected.

3221 SEARCH FOR RESONANCE IN $\pi-\pi$ INTERACTION IN π—N SCATTERING AT 0.96 BeV.
J.G.Rushbrooke and D.Radojičić.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 567-71 (Dec. 15, 1960).
110 events of $\pi^- + p \rightarrow p + \pi^- + \pi^0$ were analysed. The spectrum of events versus proton recoil lab. energy T shows a large peak at low T of order 100 MeV, confirming that the incoming pion has significant interactions with virtual mesons in the nucleon's cloud. The spectrum versus the square of the two-pion centre of mass energy, ω^2, has a striking peak at $\omega^2 = 22\,\mu^2$ which may reflect a resonance in the $\pi-\pi$ interaction at this energy. However, the spectra in separate ω^2 groups plotted against momentum transfer squared are inconclusive on this point. The group for $4\,\mu^2 < \omega^2 < 10$ has a low momentum transfer peak suggestive of a resonance in the energy region. D.W.L.Sprung

3222 π^+—PROTON SCATTERING CROSS-SECTIONS BY CHEW—LOW EXTRAPOLATION. G.A.Smith, H.Courant, E.Fowler, H.Kraybill, J.Sandweiss and H.Taft.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 571-2 (Dec. 15, 1960).
The cross-section was measured indirectly by an extrapolation to a pole in the unphysical region of neutron recoil energy in the process $p \rightarrow n + \pi^+$. 790 events of $p + p \rightarrow p + n + \pi^+$ were measured, and allowed the method to be applied in the low and high π^+ p energy regions. The derived cross-sections are qualitatively correct, confirming the feasibility of extrapolation procedures, but better statistics are needed. D.W.L.Sprung

3223 REDETERMINATION OF THE PANOFSKY RATIO FOR NEGATIVE PIONS STOPPED IN HYDROGEN. D.P.Jones, P.G.Murphy, P.L.O'Neill and J.R.Wormald.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 77-80 (Jan., 1961).
A lead—glass Cherenkov counter was used as a gamma-ray spectrometer to redetermine the Panofsky ratio for negative pions stopped in hydrogen. The ratio was found to be 1.56 ± 0.05.

3224 HOMOGENEOUS SOLID STATE IONIZATION DETECTOR.
J.D.van Putten and J.C.Vander Velde.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 124-8 (Jan., 1961) [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].
A gold-doped silicon crystal was used to measure the most probable energy loss and energy-loss distribution of π^- mesons at 1.50 BeV/c and 2.55 BeV/c. The crystal used was 2 cm in diameter and 0.25 cm thick. The preparation of the detector is discussed. The results confirm the existence of a density effect in the relation describing the dependence of the most probable energy loss on particle momentum. The energy-loss distribution appears to be broader than the predicted width.

3225 ON THE PARTICLE 550 M_e. T.Yasaki, M.Inoki, M.Machida and I.Tsushima.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 323-6.
The preliminary experimental results which led to the tentative conclusion of the existence of a particle of 550 electron masses are described. Details are given of a new experiment designed to obtain conclusive evidence about the existence of this particle. C.F.Barnaby

3226 $K^+ \rightarrow \pi^+ + e^+ + e^-$ AND $K^+ \rightarrow \pi^+ + \mu^+ + \mu^-$ DECAYS. L.B.Okun' and A.P.Rudik.
Zh.eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 600-4 (Sept., 1960). In Russian.
Considers hitherto unobserved $K^+ \rightarrow \pi^+ + e^+ + e^-$ and $K^+ \rightarrow \pi^+ + \mu^+ + \mu^-$ decays which may be due to combined electromagnetic and weak interactions. The absolute probabilities of these decays are determined by the magnitude of the $K \rightarrow \pi^-$ transition monopole moment which cannot be computed at present. The ratio of the probabilities can be calculated and was found to be $W_\mu/W_e \cong 0.2$. The π-meson, electron and muon spectra were calculated and some convenient methods for treatment of experimental results are indicated. [English translation in: Soviet Physics—JETP (USA)].

3227 THE HYPOTHESIS OF A NEUTRAL ρ^0-MESON IN THE LIGHT OF DATA ON ANTIPROTON ANNIHILATION. V.I.Goldanskii and V.M.Maksimenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 841-4 (Sept., 196 In Russian.
According to the classification proposed by Gell-Mann and Nishidzima, a neutral ρ^0-meson with zero strangeness should exis The following decay schemes for this particle were suggested: $\rho^0 \rightarrow \pi^+ + \pi^- + \gamma$, $\rho^0 = \pi_0^0 \rightarrow 2\gamma$, $\rho^0 = \pi_{10}^0 \rightarrow 3\gamma$. The possible contribution of such decays (for various ρ^0-meson masses) to annihilati of antiprotons is discussed from the viewpoint of the statistical theory of multiple processes. The data presently available on the yield of π^+, π^- and π^0 mesons during annihilation are inconsistent with the existence of a π_0^0 meson with a mass smaller than 3.5 m_π and also with the existence of a π_{10}^0 meson with a mass smaller tha

5 m_π. On the other hand the $\rho^0 \to \pi^+ + \pi^- + \gamma$ decay not only does t contradict the experimental data but even removes some diffi- lties connected with determination of the interaction volume. nglish translation in: Soviet Physics–JETP(USA)].

3228 ON THE MESON MASS DIFFERENCES.
G.W.Bund and P.Leal Ferreira.
rogr. theor. Phys. (Japan), Vol. 23, No. 3, 700-16 (April, 1960).

In view of the recent experimental evidence indicating $m(K^0) > m(K^+)$, in contrast with the well established result $m(\pi^+) > m(\pi^0)$, the problem of the electromagnetic meson self- lasses is reinvestigated. A semi-phenomenological approach is sed by introducing a nonlocal effective interaction Hamiltonian, auge invariant up to the order e^2, where new terms corresponding o one-photon and two-photon vertices are considered to take into ccount the effects of the strong interactions. It is shown that the ontrasting experimental result can be explained as the result of ie different nature of the K^0 as compared with the π^0. Some ifferent ways of reconciling the experimental results are explicitly iscussed.

3229 K^+–K^0 MASS DIFFERENCE.
K.Daiyasu and R.Sugano.
rogr. theor. Phys. (Japan), Vol. 23, No. 5, 846-52 (May, 1960).

In order to explain the K^0–K^+ mass difference by means of lectromagnetic interaction, the form factors in the Pauli term nd in the electromagnetic-polarizability-term for the meson are nvestigated. The magnitudes of contributions from these terms re estimated for the case of the exponential form factor and ompared with that from nucleons.

3230 WHIÇH IS HEAVIER: THE K_1^0-MESON OR THE K_2^0-MESON? I.Yu.Kobzarev and L.B.Okun'.
h. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 605-9 (Sept., 1960).
n Russian.

A method of determining the mass difference of the K_1^0 and K_2^0 esons is proposed which not only yields the magnitude of the differ- nce but its sign as well. The method is based on the observation of nterference of K_1^0 mesons created in plates of various substances by K_2^0 meson beam. [English translation in: Soviet Physics–JETP USA)].

3231 TEST FOR K^-–HYPERON RELATIVE PARITY.
B.A.Jacobsohn and R.M.Ryndin.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 27-9 (Jan. 1, 1961).

The absorption of K^--mesons by He is suggested as a parity est which is free from assumptions regarding the orbital state rom which the captures take place. P.K.Kabir

3232 DEMONSTRATION OF QUANTUM MECHANICS IN THE LARGE. T.B.Day.
Phys. Rev. (USA), Vol. 121, No. 4, 1204-6 (Feb. 15, 1961).

An example is given which demonstrates in a straightforward nd dramatic manner that when two particles like $(K^0 + K^0)$ or (2γ) re created simultaneously, the probabilities involved in observing ny further events related to their simultaneous creation must be alculated quantum mechanically and are correlated, even for nacroscopic distances in absorbing media. In particular, a correla- ion in the polarization of the two γ-rays from positronium annihila- ion as a function of the thickness of magnetized iron through which hey are passed is pointed out by way of a proposed experiment.

3233 ON THE TEST OF GLOBAL SYMMETRY.
T.Sakuma and S.Furui.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 522-4 (March, 1960).

It is shown that the large experimentally observed difference etween the I = 0 and 1 S-wave phase shifts for $K^- + p \to Y + \pi$ is nconsistent with global symmetry. J.E.Paton

3234 S-WAVE K MESON–NUCLEON INTERACTION.
S.Minami.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1163-73 (June, 1960).

An approach to s-wave K–N interaction is made along the same lines as the previous study of π–N scattering (Abstr. 3219 of 1961). The characteristic property of the K–N interaction in the nucleon core is expressed in terms of the change of the value of the coupling constant, and it is suggested that the introduction of the indefinite metric may be necessary to describe the phenomena in the nucleon core correctly. Moreover, an attempt to obtain the forward scattering amplitude for K–N scattering is made on the basis of the above considerations on the characteristic property of the K–N interaction. It is shown that these results are not inconsistent with experiment. The coupling constant is discussed in comparison with the results obtained by other authors.

3235 K-MESON–NUCLEON SCATTERING AND RELATIVISTIC DISPERSION RELATIONS. P.K.Roy.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 417-39 (Nov. (2), 1960).

Relativistic K-meson–nucleon dispersion relations are subjected to the type of analysis which leads one to expect a resonance in the pion–nucleon system. The P-wave equations for scalar mesons show no indication of any resonance. But the S-wave equations strongly suggest a resonant K^+–p scattering and a repulsive $\bar{K}$-nucleon potential, both in contradiction with experiment. However, for pseudo-scalar K-particles, analogous to the pion, the P-wave equations are consistent with a resonance in the I = 1, j = $\frac{3}{2}$ and one of the I = 0 states. This conclusion is not borne out by the present experimental findings and calls for detailed information about the angular distributions and the high-energy behaviour of the scattering cross-section to decide the issue. For the $\bar{K}$ particles no such resonance states are found. For the pseudoscalar K particles it is concluded, in the absence of the "accidental cancellation" which characterizes the pion case, that the I = 1 phase-shift at threshold should be given correctly by the "Born" term corresponding to a repulsive interaction, in agreement with experiment. No definitive conclusion about the S-wave behaviour of the $\bar{K}$ particles could be drawn. The main conclusion of the present work is that the dispersion theoretic analysis of non-forward scattering is capable of discriminating between a scalar and pseudo-scalar K-meson on qualitative grounds alone; it strongly indicates that these mesons are pseudoscalar.

Hyperons

3236 MODEL OF HYPERON DECAY.
L.Wolfenstein.
Phys. Rev. (USA), Vol. 121, No. 4, 1245-6 (Feb. 15, 1961).

The vanishing of the asymmetries in the decays $\Sigma^- \to n + \pi^-$ and $\Sigma^+ \to n + \pi^+$ are explained in a model in which all Σ decays occur via virtual K-meson decays. The model then predicts a Λ-decay asymmetry of similar magnitude but opposite sign to that of $\Sigma^+ \to p + \pi^0$. Certain other predictions of this model are discussed.

3237 A NOTE ON THE LEPTONIC DECAY OF HYPERONS.
Z.Maki.
Progr theor. Phys. (Japan), Vol. 23, No. 5, 853-8 (May, 1960).

The leptonic decay modes of pions and K-mesons are studied from the viewpoint of the compound model (Sakata model Abstr. 6884 of 1957). By comparing these processes ($\pi \to \mu + \nu$ and $K \to \mu + \nu$), a hypothesis for the leptonic decay of hyperons (e.g., $\Lambda \to p + \mu^- + \bar{\nu}$) is given which suggests that the (squared) bare coupling constant of this process is smaller than that of the ordinary β-decay or μ-capture process of nucleons by a factor ~10.

3238 ASYMMETRY PARAMETER OF Λ DECAY AND THE INTERMEDIATE BOSON OF WEAK INTERACTIONS.
S.Oneda, J.C.Pati and B.Sakita.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 24-6 (Jan. 1, 1961).

It is argued that a negative sign of the asymmetry parameter in $\Lambda \to p + \pi^-$ decay favours the intermediate boson theory of four-fermion interactions (Abstr. 12839 of 1960). P.K.Kabir

3239 COUPLING TYPES AND STRENGTHS OF THE Y–N–K INTERACTIONS. R.Sugano and A.Komatsuzawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 287-93 (Feb., 1960).

Analyses are made on K-N scattering with use of the dispersion relations for the charge exchange scattering $K^+n \to K^0p$ and for the ordinary elastic scattering $K^+p \to K^+p$. It is shown that (ΛNK) and (ΣNK) interactions are both pseudoscalar types or pseudoscalar and scalar types, respectively. As for the interaction strengths, it is preferable that $g_\Lambda^2 \sim 5$ and $g_\Sigma^2 = 0$ with the existing experimental data.

3240 RESONANCE IN THE $\Lambda\pi$ SYSTEM.
M.Alston, L.W.Alvarez, P.Eberhard, M.L.Good, W.Graziano, H.K.Ticho and S.G.Wojcicki.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 520-4 (Dec. 1, 1960).

A study, based on 141 events, of the energy distribution in the c.m. system of the pions emitted in the reaction

$$K^- + p \to \Lambda^0 + \pi^+ + \pi^-,$$

using a beam of 1.15 BeV/c K^-. Peaks were revealed in both the π^+

and π^- spectra at around 285 MeV, such as would be expected from the production of the pions through a quasi-two-body reaction

$$K^- + p \rightarrow Y^{*\pm} + \pi^{\mp}$$

where Y* has a mass spectrum peaking at about 1380 MeV. The shape of the calculated mass spectrum for the hypothetical "particle" Y* shows striking resemblance to the well-known $(\frac{3}{2}\,\frac{3}{2})$ resonance of the πp system. Attempts to determine the spin of the Y* from study of various possible anisotropies were inconclusive with the limited statistics. S.J.Goldsack

3241 SOME CONSIDERATIONS ON THE RECENTLY FOUND EVIDENCE FOR A $\pi\Lambda$ RESONANCE.
D.Amati, B.Vitale and A.Stanghellini.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 524-6 (Dec. 1, 1960).

See preceding abstract. The authors reconsider an earlier model of the hyperon–pion interaction (Abstr. 370 of 1960) in light of the new results. The model assumes equal parities for the Λ and Σ particles, and predicts two resonance states for $J = \frac{3}{2}$ and $T = 1$ and 2 respectively. Other resonances might develop if the Σ and Λ coupling constants were widely different. Assuming that this is not so, a definite prediction is made of the energy differences between the two resonances, the separate energies depend on the value of a cut-off. Identifying the observed resonance with that in the $T = 1$ state, a value is predicted for the energy of the other resonance which should be present for the $\pi\Sigma$ system, and for the branching ratio for the decay of the $T = 1$ state. S.J.Goldsack

3242 THE MEAN LIFETIME OF CHARGED Σ-HYPERONS AND INVESTIGATIONS ON FURTHER PROPERTIES OF THESE PARTICLES. W.Püschel.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 254-74 (Oct. (4), 1960).
In German.

The apparent discrepancy in the mean lifetime of the Σ-hyperons in emulsions was investigated by using decays in flight only and decays both in flight and at rest. All the Σ's came from K^--absorptions from which, apart from the Σ, only one fast particle was emitted. For the $\Sigma^+ \rightarrow p + \pi^0$ decay mode, using 127 decays at rest and in flight, it was found $\tau = (0.98^{+0.16}_{-0.12}) \times 10^{-10}$ sec. Using the 48 decays in flight only, $\tau = (0.60^{+0.42}_{-0.17}) \times 10^{-10}$ sec. For the mixture of $\Sigma^\pm$-hyperons from decays in flight only by the mode $\Sigma^\pm \rightarrow n + \pi^\pm$ the same maximum likelihood estimates lead to $\tau = (0.91^{+0.45}_{-0.19}) \times 10^{-10}$ sec. By combining the present data (191 decays), that of Istituto di Fisica Bologna (114 decays), Ecole Polytechnique Paris (74 decays), and Istituto di Fisica Parma (68 decays), it is shown that there is no evidence for a lifetime doublet. Comparison with other data is also made and it is concluded that the best value for the Σ^+-hyperon lifetime is $\tau = (0.95^{+0.07}_{-0.05}) \times 10^{-10}$ sec. Angular distributions in Σ-decay are analysed for information on parity conservation in Σ-production. No evidence for a parity non-conservation in Σ-production is found. Measurements of the masses of the charged Σ-hyperons and the K^--meson are reported. The terminal behaviour of the Σ^--hyperons was also studied.

3243 MASS DIFFERENCE BETWEEN THE SIGMA HYPERONS. A.H.Zimerman.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 353-65 (Feb., 1960).

The problem is discussed within the general framework of the electromagnetic structures of elementary particles. Several possibilities are considered for the values of the anomalous magnetic moments, especially those which according to meson theory have a reasonable magnitude and sign. Assuming the external distributions of charge and anomalous magnetic moments, as well as the magnitudes of these moments, the inner structures are predicted in order to explain the mass differences of the triplet. Effects of higher-order corrections due to strong interactions are also discussed.

3244 INELASTIC SCATTERING OF A Σ^- HYPERON WITH AN EMULSION NUCLEUS. H.E.Fisk and D.J.Prowse.
Phys. Rev. (USA), Vol. 121, No. 4, 1202-4 (Feb. 15, 1961).

During a systematic study of fast hyperons resulting from the nuclear capture of K^- mesons, an event was found which is interpreted as the elastic scattering of a Σ^- hyperon by a bound neutron. The reaction kinematics are insufficient to determine the nature of the nuclear potential for Σ^- hyperons but it appears that when about 10 of these events have been found and analysed, it will be possible to infer the sign of the potential from the general effect it will have on the observable kinematics of the events.

Deuterons

3245 ELECTRIC MULTIPOLE TRANSITIONS IN THE D(γp)n REACTION AT HIGH ENERGY. M.Matsumoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 188-90 (Jan., 1960).

Calculations performed for E1 and E2 transitions at energies in the range 20-100 MeV, retaining all the terms in the Kγr expansion series, show that it is unjustified to break off the series after the first term, even at 80 MeV. A calculation for the range 80-300 MeV was also made, including retardation effects and all electric multipole orders, taking plane waves for the final state and a pion-theoretic wave function for the deuteron. The fit to the differential cross-section is appreciably better than that obtained without the retardation effects, but little different from that including E1 and E2 transitions only. The hump in the excitation function around 280 MeV is not obtained. [In the title above "multipole" has been substituted for the original "multiple", which seems to be a printer's error.] I.J.R.Aitchison

3246 ELASTIC SCATTERING OF 24.4 MeV DEUTERONS BY PROTONS. W.T.H.van Oers and K.W.Brockman, Jr.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 189-95 (Nov. (5), 1960).

The differential cross-section for the elastic scattering of 24.4 MeV deuterons by protons (equivalent to 12.2 MeV p–d scattering) was measured at angles between 15° and 170° in the centre-of-mass system with an overall accuracy of the order of 3%. The measurements stand in good agreement with the recent measurements near 10 and 14 MeV and show the same apparent disagreement with the theory of Christian and Gammel (1953) in the Coulomb-nuclear interference region.

3247 PHOTODISINTEGRATION OF THE DEUTERON IN THE HIGH ENERGY RANGE. M.Matsumoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 597-609 (April, 1960).

The differential and total cross-sections for photodisintegration are calculated for incident photon energies in the range 80-300 MeV. A full expression for the electric interaction between the deuteron and radiation is used without expansion in terms of κ of each multipole or multipole transition. For the initial state, the pion-theoretical deuteron wave-function adopted has almost 7% of D-state mixture. The plane wave is used for the final state. The conclusions are: (1) κ expansion is not justified in the energy range $E_\gamma \gtrsim 80$ MeV and gives an underestimate for the cross-sections; (2) multipoles higher than E2 have no affect for $E_\gamma \lesssim 80$ MeV; (3) the large D-state mixture is important; (4) retardation effects are important at energies so high that meson effects have to be considered. It is shown that the excitation function agrees with the observed data in the energy range if the meson effects are added to the result.

3248 MEASUREMENT OF DEUTERON POLARIZATION PRODUCED BY d–α SCATTERING AT 1.07 MeV.
L.G.Pondrom and J.W.Daughtry.
Phys. Rev. (USA), Vol. 121, No. 4, 1192-4 (Feb. 15, 1961).

Elastic scattering from He^4 gas in the energy region of the 1.07 MeV resonance was used to polarize deuterons. After scattering through 30° in the lab by the polarizer, the polarization of the deuteron beam was analysed by the reaction $He^3(d,p)He^4$ near 400 keV. This was accomplished by observing protons at 0° and 90° and measuring the dependence of the counting rate ratio on the deuteron polarization. $He^3(d,p)He^4$ is well described in this energy region by a single-level Breit–Wigner formula, and therefore has a predictable sensitivity to deuteron polarization. The experimental results are consistent with the magnitude of the polarization component $\langle T_{20} \rangle$ calculated from the d–α phase-shift analysis.

Alpha-particles

3249 THE ELASTIC SCATTERING OF ^{3}He BY ^{3}He. B.H.Bransden and R.A.H.Hamilton.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 987-9 (Dec., 1960).

A calculation is made using an "equivalent" central nuclear potential. The results for the differential cross-section at 20. 26 and 29 MeV are compared with experiment. Agreement is only satisfactory for angles greater than 60°. The experimental dip at ~ 40° is not given by the calculation. A.Ashmore

3250 SILICON SURFACE-BARRIER NUCLEAR PARTICLE SPECTROMETER. J.L.Blankenship and C.J.Borkowski.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 190-5 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

Gold silicon surface-barrier counters which give good resolution at room temperature were made. Counters from 150 ohm cm material gave 15 keV (~ 0.25%) resolution for Cm^{244} (5.801 MeV) and Am^{241} (5.477 MeV) alpha particles. A large-area 1 cm^2 counter gave 0.7% resolution for Po^{210} (5.30 MeV) alpha particles. The detector resolved alpha-particle groups which previously had been unresolved with Frisch-grid pulse-ion chambers.

3251 AN ENCAPSULATED SILICON JUNCTION ALPHA-PARTICLE DETECTOR.
P.P.Webb, R.L.Williams and R.W.Jackson.
IRE Trans nuclear Sci (USA), Vol. NS-7, No. 2-3, 199-201 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The construction of a Si diffused-junction alpha detector in a form which allows complete encapsulation and protection of the junction edge, and which preserves a good geometry, is described. The unit is inherently shielded from electrical pickup, and is shielded from ambient light by a thin metallic film over the sensitive surface. A modified form of the same encapsulation has been used for large area units of 2 cm^2 suitable for contamination monitoring. Measurements of energy resolution and other characteristics are reported for units of sensitive area 5 mm^2, 20 mm^2 and 200 mm^2.

3252 IMPROVEMENTS IN ENCAPSULATED SILICON JUNCTION ALPHA DETECTORS.
R.W.Jackson, P.P.Webb and R.L.Williams.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 29-34 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Detectors made with material of 1000 ohm cm resistivity and with a front-layer depth of 2 μ are available with window areas of 5, 20 and 200 mm. Recent measurements on the best of these units gave resolutions of 0.6%, 0.9% and 4% for 5.5 MeV alpha particles. Similar units were made with a front-layer depth of 0.2 μ and using material of resistivity up to 30 000 ohm cm. Excitation of carriers by radiation of optical wave-lengths shows that the effective dead layer is less than 0.03 μ. The necessity of making a solder contact and seal to the extremely thin front layer raises problems in the achievement of high stability, low leakage, and low noise at high voltages. Thus the depletion layer depths obtainable in encapsulated units with high resistivity material do not yet approach those obtainable in unencapsulated units in vacuum. A representative measurement gave a resolution of 0.6% with a window area of 5 mm^2 (junction area 20 mm^2) and a depletion-layer depth of 180 μ.

3253 N.I.P. SILICON JUNCTIONS DETECTORS.
L.Koch, J.Messier and J.Valin.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 43-9 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Silicon junctions with an n-i-p structure were used as particle detectors. They consisted of an intrinsic 1000 ohm cm p-type Si plate, with n- and p-diffused layers on respective faces giving the n-i-p structure. Alpha-particles were incident on the i-region, parallel to the junction plane. An energy resolution of 2%, and good pulse-height versus particle-energy linearity up to 40 MeV were obtained.

3254 THE APPLICATION OF SILICON DETECTORS TO ALPHA PARTICLE SPECTROSCOPY.
A.Chetham-Strode, J.R.Tarrant and R.J.Silva.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 59-63 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

The sensitivity for detection of low abundance groups in an alpha spectrum was found to be limited primarily by a low-energy tail in the pulse-height distribution. The effects of scattering and source preparation on the magnitude of this tail were experimentally investigated. A theoretical lower limit of sensitivity for low abundance groups was calculated from consideration of scattering processes in the crystal. Background contamination in new detectors and the increase in background due to the collection of recoil nuclei were studied. Methods for minimizing the increase in background are suggested. A chamber, designed from a consideration of the foregoing results, was constructed and used for the detection and measurement of low abundance groups in the alpha spectra of U^{234} and the actinium decay series.

3255 dE/dx AND E SEMICONDUCTOR DETECTOR SYSTEMS FOR 25 MeV He^3 AND ALPHA PARTICLES.
H.E.Wegner.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 103-11 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Construction of suitable detectors is described, and the experimental results are presented.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

3256 A NUCLEAR INTERACTION OF A PROTON OF ABOUT 10^{15} eV PRODUCING AN ELECTRON–PHOTON CASCADE OF 2.4×10^{13} eV.
M.W.Teucher, E.Lohrmann, D.M.Haskin and M.Schein.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 26-9.

In a stack of 22 litres of Ilford G5 emulsion flown by balloon for 13 hours at a height of over 110 000 ft at Texas, a nuclear interaction initiated by a proton of type 6 + 16p was found. The primary proton energy was probably between 10^{14} and 10^{15} eV. Between the three innermost tracks of the forward cone, at a distance of about 4 mm from the origin, an unusually energetic electron–photon cascade was initiated which could be followed for 22.5 cm in the stack. Details are given of the particles in the emulsion, including the angular distribution of the shower particles, the development of the electron–photon cascade and the lateral distribution of electrons. This event seems to be the highest energy proton collision in nuclear emulsions which has been described so far. It shows that the primary proton spectrum extends to these very high energies.

C.F.Barnaby

3257 SPECTRUM OF γ-RAYS AND NUCLEAR-ACTIVE COMPONENT OF AIR-SHOWERS AT 11 000 METRES. I.
J.Duthie, C.M.Fisher, P.H.Fowler, A.Kaddoura, D.H.Perkins and K.Pinkau.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 30-4.

In 1958 two stacks were exposed in high flying aircraft. Each stack consisted of vertical sheets of lead and emulsion. One stack was exposed for 1200 hours and the other for 600 hours, at a mean altitude of 38 000 ft (220 gm/cm^2 residual atmosphere). The results are given of the analysis of 600 electromagnetic cascades. The γ-ray energy spectrum had a slope of -3.5 ± 0.3 which is about double that of the accepted primary spectrum. The results suggest that, at extremely high energies, the primary nucleons dissipate progressively less energy into the soft component, at least in the early collisions, and it is therefore suggested that the conventional picture of the nucleonic cascade may need drastic revision.

C.F.Barnaby

3258 SPECTRUM OF γ-RAYS AND NUCLEAR-ACTIVE COMPONENT OF AIR-SHOWERS AT 11 000 METRES. II.
J.Duthie, C.Fisher, P.H.Fowler, A.Kaddoura, D.H.Perkins and K.Pinkau.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 35-40.

In Pt I evidence was presented which strongly suggests that in nuclear collisions in air both the amount of energy transformed into π^0-mesons and their number are nearly independent of primary energy. In this paper additional evidence is presented which gives information on the partition of energy among the π^0-mesons in three disintegrations of 10^{15} eV energy that occurred outside the emulsion stack so that the individual high energy γ-rays were well separated and individual energy estimations could be performed.

C.F.Barnaby

3259 INTERACTION OF HIGH-ENERGY NUCLEONS WITH COMPLEX NUCLEI. T.P.Lazareva and P.A.Usik.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr 7427 of 1960) Vol. I, p. 77-81.

The fact that experimental data show that the mean number of gray and black tracks in the disintegrations of the nuclei of photographic emulsions by high-energy nucleons is greater than theoretically predicted is discussed. It is shown that the plural-multiple theory is in best agreement with the experimental results. The results of an analysis of the events recorded in photographic emulsions exposed during 1955 were used to determine the energy spectrum of the primary shower-producing particles. C.F.Barnaby

3260 ON THE MULTIPLE PRODUCTION OF PARTICLES IN THE INTERACTION OF NUCLEONS OF ENERGY 10^{10}-10^{13} eV WITH EMULSION NUCLEI.
A.P.Zhdanov, I.M.Kuks, N.V.Skirda and R.M.Yakovlev.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 95-8.

This paper presents the preliminary results of an investigation attempted to determine the nature of the interaction of high energy particles (10^{10}-10^{13} eV) with atomic nuclei. The authors attempt to obtain information about the mechanism of the multiple production of particles by studying the distribution of shower particles over both polar and azimuthal angles. Attention is drawn to the existence in the experimental data of jets of very high multiplicity, the latter being considerably higher than one could expect with a tunnel type of shower-generating model. 74 jets were selected for measurement, of which 64 were initiated by singly-charged particles and 10 by neutral particles. The total angular distributions of shower particles and the characteristics of "anomalous" jets are given.
C.F.Barnaby

3261 ON THE ANGULAR DISTRIBUTION OF SHOWER PARTICLES IN EXPLOSIVE SHOWERS PRODUCED BY HIGH-ENERGY COSMIC RAY PARTICLES.
A.P.Mishakova and B.A.Nikolsky.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 99-106.

The results presented are based on the analysis of 39 showers found when scanning emulsion stacks exposed to cosmic rays at the heights of 23-27 km in 1956 and 1957. It is shown that upon a direct transformation from the laboratory coordinate system to the c.m. system, the angular distribution obtained is asymmetrical with respect to the angle, i.e. the number of shower particles in the vicinity of angles close to 180^0 is considerably greater than the number of particles close to 0^0 in the c.m. system. The experimental data of the dependence of the number of shower particle pairs on pair angle is in accordance with a symmetric c.m. system shower particle angular distribution, but there seems to be no systematic pair correlation of shower particles. C.F.Barnaby

3262 THE ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN HIGH-ENERGY NUCLEAR COLLISIONS WITH HEAVY NUCLEI OF PHOTOGRAPHIC EMULSION.
J.Bartke, P.Ciok, J.Gierula, R.Hołyński, M.Miesowicz and T.Saniewwaka.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 113-17.

The characteristics of jets produced in photographic emulsions in collisions of nucleons with heavy nuclei have been investigated and the results compared with the predictions of the hydrodynamical theory and the two-centres model, with particular reference to the angular distributions of secondary particles. C.F.Barnaby

3263 ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES AT NUCLEAR INTERACTION WITH HEAVY NUCLEI OF EMULSIONS.
J.P.Soo, G.B.Zhdanov and M.I.Tretjakova.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol.I, p. 118-20.

The analysis of the results obtained from measurement on eleven jets produced in photographic emulsions by neutral or singly-charged particles is used to compare the angular distributions of the secondary particles with the predictions of the hydrodynamical theory. C.F.Barnaby

3264 ASYMMETRIES IN THE ANGULAR DISTRIBUTION OF JET PARTICLES.
J.Pernegr, V.Petržílka and V.Šimák.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr 7427 of 1960) Vol. I, p. 127-9.

Azimuthal asymmetry in the distributions of secondary jet particles has been proposed by Kraushaar and Marks (Abstr. 3886 1954) and by Koba and Takaji (Abstr. 3753 of 1959) as a consequenc of the two-centres model. The experimental investigation of this effect is discussed. C.F.Barnab

3265 METHODS, PROPOSED BY MOSCOW UNIVERSITY, OD STUDYING THE ELEMENTARY ACT OF INTERACTIC OF NUCLEAR-ACTIVE PARTICLES OF ENERGY 10^{11}-10^{14} eV WITH ATOMIC NUCLEI. N.L.Grigorov, N.A.Kondratiev, A.I.Savel'eva, V.A.Sobinyakov, A.V.Podgurskaya and V.Ya.Shestope
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr 7427 of 1960) Vol. I, p. 130-5.

Because the study of the characteristics of the interaction of high-energy particles with nuclei often requires a precise knowled of the energy of the primary particle, a method of measuring such an energy for the range 10^{11}-10^{14} eV is described. The instrumen used is an ionization calorimeter consisting of 184 cylindrical ioni zation chambers of 1 m length, 6 cm diameter. Details of the design and operation of the instrument are given and the results ob tained by exposing one to the cosmic radiation at an altitude of 3200 m are given with particular reference to the observation of 27 cases of "young" electron--photon showers of total energy grea than 2×10^{12} eV. C.F.Barnab

3266 ANALYSIS OF JETS FROM CARBON.
W.B.Fretter and L.F.Hansen.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abst 7427 of 1960) Vol. I, p. 136-42.

The experiment described was designed to ameliorate, if not eliminate, two fundamental difficulties with the nuclear emulsion technique when applied to the analysis of the nature of nucleon–nucleon interaction processes. These difficulties are: the proble of identifying the struck nucleus since the emulsion is a mixture o elements and the difficulty of identification of the particles emerg from the interaction which can only be made in a limited range of energies. The target material was carbon where the probability striking more than one nucleon is fairly low and the analysis was made in a cloud chamber where identification of the emergent par cles was possible up to energies of 15-18 BeV. In nine months of operation at sea-level about 100 nuclear interactions in the carbo were observed; of these 41 contained three or more nuclear partic and the result of measurements made on these showers are given. The average transverse momentum for all the secondaries was (308 ± 23) MeV/c. The distribution of total energies of the heavy particles had a peak at about 1 BeV while the pions had a peak at about 250 MeV/c total energy. There was no significant differenc between the distributions of the transverse momenta of the heavy particles and of the pions. The angular distribution for both heavy particles and pions was anisotropic but the heavy particles were more anisotropic than the pions. The inelasticity decreased from 0.3 ± 0.1 at $\gamma_c = (1 - \beta^2)^{-1/2} = 7$ to 0.07 ± 0.04 at $\gamma_c = 25$ if the collision were taken as nucleon–nucleon. Values of the multiplici are given and it is shown that they are low compared with the resu from emulsions. The percentage of strange particles to the total number of emergent particles in the collision was 24 ± 7 for all t showers observed, assuming that all negative heavy particles wer strange. C.F.Barna

3267 ON ONE PARTICULARITY OF INTERACTIONS OF PARTICLES WITH AN AVERAGE ENERGY OF 200 Be
N.G.Birger, S.A.Slavatinsky and Yu.A.Smorodin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abst 7427 of 1960) Vol. I, p. 154-6.

The kinematic method of analysis (see Abstr. 9307 of 1960) is applied to these interactions. C.F.Barna

3268 ON THE DETERMINATION OF THE ENERGY OF FAS PARTICLES FROM ANGULAR DISTRIBUTION OF TH INTERACTION PRODUCTS.
A.I.Nikishov, I.L.Rosenthal and S.A.Slavatinsky.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr 7427 of 1960) Vol. I, p. 157-60.

The method used for the determination of the energy of fast particles is at present based on an analysis of the angular distribution of secondary particles and of the simplest relationships of

elativistic kinematics. The method is based on two assumptions: .) the velocities of the secondary particles are approximately the elocity of light and (2) the divergence of particles in a system ssociated with the centre of mass occurs symmetrically with espect to the plane perpendicular to the line of motion. The signifi- ance of these assumptions is discussed. C.F.Barnaby

3269 PERIPHERAL COLLISIONS.
S.A.Slavatinsky and D.S.Chernavsky.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 127 of 1960) Vol. I, p. 161-6.

Because cases have been found in recent years with an anomalous ngular distribution in the c.m. system of nucleons and with a low elasticity coefficient, which have been interpreted as resulting from eripheral interactions, the interest in peripheral collisions has rown considerably. The theoretical description of the phenomena sing the Weiczacker–Williams method is discussed in detail. Ex- erimental results are compared with the theoretical predictions. C.F.Barnaby

3270 DISCUSSION IN MOSCOW STATE UNIVERSITY.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 167-9.

The asymmetry of nucleon–nucleon collisions, the size of ransversal momentum of particles from nuclear interactions and -radiation spectra are discussed. C.F.Barnaby

3271 A STUDY OF THE INTERACTION OF 10^{11}-10^{12} eV PARTICLES WITH IRON AND GRAPHITE NUCLEI.
.P.Babayan, N.L.Grigorov, M.M.Dubrovin, L.S.Mishchenko, .S.Murzin, L.I.Sarycheva, V.A.Sobiniakov and I.D.Rapoport.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960), Vol. I, p. 174-81.

The experimental arrangement comprised an ionization calori- eter, 184 pulse ionization chambers, a hodoscope and a large ilson chamber. The apparatus was operated at 3200 m above sea evel at Moscow. The flux of nuclear-active particles of energy xceeding 10^{12} eV was found to be $(1.8 \pm 0.8) \times 10^{-8}$ cm^{-2} sec^{-1} terad^{-1}. The inelasticity of the interaction of $\geq 2 \times 10^{11}$ eV pri- aries with iron nuclei was 1.0 ± 0.09. The average inelasticity of he interaction of $\geq 10^{11}$ eV primaries with carbon nuclei was less an half that of iron. These experimental inelasticity values ex- lude the possibility of consecutive collisions with single nucleons or mall groups of nucleons when $\geq 10^{11}$ eV primaries interact with heavy uclei. It was also found that in the range 10^{10}-10^{11} eV of nucleon nergies interactions with heavy nuclei suffer a qualitative change in ature, characterized by a sharp rise in primary energy loss in assing from light nuclei to iron nuclei. The nature of the spectrum f secondary nuclear-active particles is discussed in detail. C.F.Barnaby

3272 PRODUCTION OF UNSTABLE PARTICLES IN NUCLEAR HIGH-ENERGY INTERACTIONS AND THEIR ROLE IN THE NUCLEAR CASCADE PROCESS. V.F.Vishnevsky.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. I, p. 188-96.

The absorption of nuclear-active particles by air and by water s discussed and it is concluded that the so-called density transition ffect affects the measurement of absorption of higher-energy uclear-active particles in water down to a depth of 2 m. Above is depth its influence is insignificant, the absorption length of ctive particles in water is given as about 180 g/cm^2 while in air is close to 120 g/cm^2. This difference is conserved up to energies f about 500 BeV. The reasons for this difference are discussed. C.F.Barnaby

3273 INVESTIGATION OF THE FORMATION OF THE SOFT COMPONENT USING ČERENKOV COUNTERS.
.A.Azimov and T.S.Yuldashbaev.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. I, p. 197-201.

The relation between the energy transferred to the soft compo- ent and the energy of the primary particles, which is of importance n understanding the mechanism of the formation of electron– uclear showers, was investigated using Cherenkov counters at amirs in 1958. Over eight thousand showers were selected and nalysed by three methods. It was found that the mean fraction of nergy transmitted to the soft component remains constant for rimary particle energies of 50 BeV to about 150 BeV. However, in he 100-500 BeV range of primary energies, a perceptible decrease in the energy transfer to the soft component was observed. A de- crease of 30% of the original energy took place in the mean fraction of energy transmitted to the soft component. C.F.Barnaby

3274 ON THE ABSORPTION OF HIGH-ENERGY NUCLEAR-ACTIVE PARTICLES IN AIR AND IN A DENSE ABSORBER. S.A.Azimov, Yu.P.Kratenko, L.S.Khavin, A.A.Yuldashev and R.Karimov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 202-6.

The absorption of nuclear-active particles in water down to depths of 10-11 m was measured with the aid of three types of apparatus. In one apparatus, the electron-nucleon showers were selected according to penetrating particles by counters; in another according to the electron–photon component by means of an ioni- zation chamber, and in the third, the non-equilibrium soft compo- nent was selected by a counter telescope. The absorption coefficient of nuclear-active particles (in the energy range from 10^{10} to 10^{11} eV) using data from the three methods was found to be 185-210 g/cm^2 in water and 120 g/cm^2 in air. It is concluded that the absorption coefficient of nuclear-active particles in water is not affected by the density transition effect. C.F.Barnaby

3275 MORE ACCURATE DEFINITION OF THE HYDRO- DYNAMICAL THEORY OF MULTIPLE PARTICLE PRODUCTION. G.A.Milechin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 209-15.

An extension to the work of Landau (see Abstr. 5771 of 1954), is suggested and a generalization of the theory for the case of nucleon–nucleus collisions is deduced. The distribution of the energies, transverse momenta and angles of secondary particles is discussed. C.F.Barnaby

3276 ON THE EFFECT OF VISCOSITY ON ENERGY DISTRI- BUTION OF SECONDARY PARTICLES IN THE PRO- CESS OF MULTIPLE PRODUCTION.
A.A.Yemelyanov and D.S.Chernavsky.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 216-19.

Most works on the hydrodynamical theory of multiple particle production employ the equations of a relativistic ideal liquid neglecting viscosity. The effect of viscosity intensifies dissipation of energy, increases entropy and, therefore, the number of secondary particles; and also the appearance of new particles can change the energy distribution particularly when the number of particles is small and the energy carried by them is great. This paper discusses the number of particles produced due to viscosity in the simple wave region. This region is of interest because even a small number of surplus particles can essentially change the energy distribution. Also all gradients of velocities are greater in this region and there- fore the effect of viscosity is more important. Because it is impossible to determine the viscosity coefficient of a relativistic liquid exactly, the results are of a qualitative nature. C.F.Barnaby

3277 ANALYSIS OF POSSIBLE HYDRODYNAMICAL THEORIES OF MULTIPLE PARTICLE PRODUCTION WITH DIFFERENT EQUATIONS OF STATE. G.A.Milekhin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 220-5.

It is pointed out that the various theories of multiple particle production can differ either by an equation of state at the hydro- dynamical approach or by a Lagrangian at the field approach. An analysis of hydrodynamical theories with different equations of state is given. It is also shown that the results obtained for a certain class of Lagrangians with an appropriate approximation are the same as in the hydrodynamical theory with a corresponding equation of state. C.F.Barnaby

3278 A MODEL FOR MULTIPLE MESON PRODUCTION IN NUCLEON–NUCLEON COLLISIONS. K.Niu.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 234-43.

A new model of multiple meson production in nucleon–nucleon collisions, based on experimental results from high-energy jets, the two-hump structure of the secondary mesons, and the persist- ency of the primary nucleon throughout the collision, is discussed with reference to the experimental data. C.F.Barnaby

ASYMMETRY EFFECTS AND VARIOUS MODELS OF HIGH-ENERGY NUCLEAR COLLISIONS. See Abstr. 3429

IMPACT PARAMETER AND PERTURBATION TREATMENT OF THE DISTANT COLLISION OF NUCLEONS WITH PION EMISSION. See Abstr. 3170

3279 POLARIZATION OF COSMIC RAY μ-MESONS. A.T.Alikhanyan.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 317-19.

The results of experiments to study the dependence of μ-meson polarization on the momentum are discussed. The meson polarization was determined by observing the asymmetry of positron angular distribution when the mesons stopped and decayed in copper. The meson momentum was determined from the amount of absorber placed above the equipment, which consisted of a hodoscope arrangement (operated at Moscow); measurements were made on μ-mesons having momenta of 0.35, 1.05 and 1.5 BeV/c. In each case about 2000 decays were observed. The polarizations obtained were 0.21 ± 0.08, 0.35 ± 0.087 and 0.52 ± 0.083, respectively. These results are compared with those of other workers and their significance is discussed. C.F.Barnaby

3280 GENERAL DESCRIPTION OF AN INSTALLATION FOR INVESTIGATION OF EXTENSIVE AIR SHOWERS AND PRELIMINARY RESULTS OBTAINED FROM ITS OPERATION. S.N.Vernov, G.B.Khristiansen, A.T.Abrosimov, N.N.Goryunov, V.A.Dmitriev, G.V.Kulikov, Yu.A.Nechin, S.P.Sokolov, V.I.Solovieva, K.I.Soloviev, Z.S.Strugalsky and B.A.Khrenov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 7-17.

A large-scale installation at Moscow University for a complex study of extensive air showers is described. The elaborate assembly consists of simultaneously operating physical instruments including counter hodoscopes containing 4400 Geiger–Müller counters with a total area of over 100 m^2, about 150 ionization chambers with a total area of 13 m^2, each connected to a channel analyser, and a large diffusion cloud chamber with an area of 0.64 m^2. This equipment is being supplemented by 20 luminescent counters with a total area of 10 m^2 and a diffusion cloud chamber of area of about 5 m^2. The equipment was designed for a comprehensive and simultaneous investigation of all the major components (electrons, photons, nuclear-active particles and μ-mesons) of an extensive air shower at sea-level. The lateral distribution of particles and energy fluxes of various components are measurable even in individual showers. For most showers, it is possible to obtain simultaneous information on the electron–photon, on the nuclear-active, and on the μ-meson component of a given recorded shower. It is also possible to study showers of ultra-high-energy simultaneously with the investigation of medium-energy showers. Preliminary results obtained with the apparatus are given. Considerable attention was given to studying the structure of an extensive air shower very close to its axis where the particles with maximum energies are concentrated.
C.F.Barnaby

3281 M.I.T. AIR SHOWER PROGRAM. B.Rossi.
Cosmic Ray Conference Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 18-30.

Four air-shower experiments are described: (1) at Agassiz, Massachusetts (42°N), at 100 m using an apparatus with a sensitive area of 1.9×10^5 m^2; (2) at Kodaikanal, India (10°N), 2034 m altitude and 1.3×10^3 m^2 sensitive area; (3) at Alto, Bolivia (16°S), 4100 m altitude and 3.9×10^5 m^2 sensitive area; (4) at Volcano Ranch, New Mexico (35°N), 1900 m altitude and 1.2×10^7 m^2 sensitive area. The results from the Agassiz and Kodaikanal experiments include data on the lateral density distribution, the size spectrum, the atmospheric absorption and the distribution of arrival directions.
C.F.Barnaby

3282 CERENKOV RADIATION PRODUCED BY EXTENSIVE AIR SHOWERS OF COSMIC RAY. A.E.Chudakov, N.M.Nesterova, V.I.Zatsepin and E.I.Tukish.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, 50-7.

Use is made of the Cherenkov radiation to study the properties of the showers. Since the light flux is produced along the entire path of the shower through the atmosphere and, under favourable conditions, is not absorbed by it, the method makes it possible to study the development of each recorded shower with respect to depth. Measurements made at Pamir (3860 m), with ten light detectors and nine hodoscopes are described. A large number of showers with the number of particles between 2×10^4 and 1.3×10^7 were analysed. The shower integral spectrum was found to be of the form $(4.6 \pm 1.4) \times 10^{-7}\ (N \times 10^{-6})^{1.6 \pm 0.15}$ m^{-2} sec^{-1} $sterad^{-1}$. The relation between light intensity and primary energy is discussed in detail. C.F.Barnaby

3283 SPECTRUM OF EXTENSIVE AIR SHOWERS IN A NUMBER OF PARTICLES AT 200 AND 3860 METERS ABOVE SEA LEVEL. G.V.Kulikov, N.M.Nesterova, S.I.Nikolsky, V.I.Solovieva, G.B.Khristiansen and A.E.Chudakov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 85-8.

The data obtained on the spectrum of extensive air showers, in the particle-number interval 4×10^3 to 3×10^7, at altitudes of 200 and 3860 m are discussed. It is shown that the integral spectra of the showers can be approximated by a power function of the form $(4.6 \pm 1.4) \times 10^{-11} \left(\frac{N}{10^6}\right)^{-(1.60 \pm 0.15)}$ cm^{-2} sec^{-1} $sterad^{-1}$, where N is the number of particles. The absorption coefficient of showers containing more than 10^5 particles was found to be 156 ± 22 g/cm^2.
C.F.Barnaby

3284 AIR SHOWERS AT ALTITUDES OF 9-12 km. R.A.Antonov, Yu.A.Smorodin and Z.I.Tulinova.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 96-100.

A study of the density-spectrum of extensive air showers at altitudes of 9-12 km by means of an array of counter hodoscopes is described. Details of the result are given and it is shown that the lateral distribution of the axes of the showers recorded does not change very much with different shower sizes. The variation of the lateral distribution of electrons in extensive air showers with altitude is discussed. The integral spectra of showers containing between 5×10^5 and 5×10^7 particles were found to be, at 9 and 12 km, $3 \times 10^{-11} (5 \times 10^6/N)^{1.7}$ and $1.7 \times 10^{-11} (5 \times 10^6/N)^{1.8}$ cm^2 sec^{-1} $sterad$ respectively. The total numbers or primary particles with an energy greater than E_0 per cm^2 sec^{-1} $sterad^{-1}$ at 9 km were found to be: 4.3×10^{-10} for $E_0 = 5 \times 10^{14}$ eV; 1.2×10^{-11} for $E_0 = 5 \times 10^{15}$ eV; and 3.8×10^{-13} for $E_0 = 5 \times 10^{16}$ eV. At 12 km the figures are 4.1×10^{-10}, 1.0×10^{-11}, and 2.4×10^{-13} for E_0 equal to 5×10^{14}, 5×10^{15} and 5×10^{16} eV respectively. C.F.Barnaby

3285 INDEPENDENCE OF LATERAL DISTRIBUTION AND SIZE OF EAS. J.Delvaille, F.Kendziorski and K.Greisen.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 101-5.

The discrepancies obtained in the experimentally determined values of the exponent in the number spectrum of extensive air showers are discussed. It is concluded that it is not possible to say which of the determined number spectra is the more correct.
C.F.Barnaby

3286 CLOUD CHAMBER STUDY OF EXTENSIVE AIR SHOWERS. T.Gemesy, T.Sandor and A.Somogyi.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 106-8.

Measurements of the transition effect of extensive air showers in lead and the photon/electron ratio in extensive air showers are described. A cylindrical cloud chamber, controlled by a fourfold coincidence system, and with an effective area of 300 cm^2, was used. The photon/electron ratio obtained was 1.44 ± 0.07. The agreement between the experimental data and the figures predicted by the electromagnetic cascade theory was remarkably good. It was found that the photon/electron ratio was not significantly dependent on the shower density in the density range 30-200 particles/m^2. The transition effect in lead is discussed in detail. C.F.Barnaby

3287 ON THE FUNCTION OF LATERAL DISTRIBUTION OF CHARGED PARTICLES AND OF THE DENSITY OF THE ELECTRON–PHOTON COMPONENT ENERGY FLUX IN AN EXTENSIVE AIR SHOWER. S.N.Vernov, N.N.Goryunov, V.A.Dmitriev, G.V.Kulikov, Yu.A.Nechin, V.I.Solovieva, Z.S.Strugalsky and G.B.Khristiansen.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 109-14.

Results are given of an experiment performed with a diffusion cloud chamber and a hodoscope arrangement, during which 20 000

extensive air showers were recorded. The experimental data obtained show considerable fluctuations in the absolute energy fluxes of the electron-photon component. The dependence of mean energy on distance is discussed and it is shown that the dependence indicates a substantial role of nuclear scattering. C.F.Barnaby

3288 INVESTIGATION OF HIGH-ENERGY NUCLEAR-ACTIVE COMPONENT OF EXTENSIVE AIR-SHOWERS AT SEA LEVEL. S.N.Vernov, N.N.Goryunov, V.A.Dmitriev, G.U.Kulikov, Ya.A.Nechin and G.B.Khristiansen.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 115-121.

The high-energy nuclear-active component of extensive air showers was studied using the apparatus described by Dmitriev et al. [Nuovo Cimento Suppl. (Italy), Vol. 8, No. 2, 587 (1958)]. From the results obtained it was concluded that for sea-level showers containing between 10^4 and 10^6 particles the nuclear-active component carries an energy which, on the average, approximates to that carried by the total electron–photon component at the observation level. The lateral distribution of the energy flux of the nuclear-active component between 1 and 10 m from the axis is described by the law $r^{-2.0\pm0.25}$. The integral energy spectrum of the high-energy nuclear-active particles is discussed is detail. C.F.Barnaby

3289 SPATIAL DISTRIBUTION OF THE ENERGY FLOW OF E.A.S. ELECTRON-PHOTON AND NUCLEAR-ACTIVE COMPONENTS AT AN ALTITUDE OF 3860 M ABOVE SEA-LEVEL. S.I.Nikolsky and E.I.Tukish.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 129-33.

To determine the density of energy flow, 12 cylindrical ionization chambers were placed under lead absorbers of various thickness, ranging from 1 to 80 cm. The apparatus, run at an altitude of 860 m, made it possible to obtain the spatial distribution of the energy flow density in the distance interval 0.2-30 m from the shower axis in showers with between 2×10^5 and 4×10^5 particles, and in the distance interval 0.2-20 m in showers with between 6×10^4 and 2×10^5 particles. The spatial distributions obtained do not depend on the number of particles in the shower and have the form $r^{-1.8}$ for $0.5\ m < r < 8\ m$ and r^{-2} for $8\ m < r < 30\ m$. The energy in a circle with radius 30 m was found to be 7.7×10^{13} eV for showers with an average size of 3×10^5 particles, and 2.5×10^{13} eV for showers with an average size of 10^5 particles. The spatial distribution of the density of the energy-flow for the electron-photon component could be approximated to a power law of the form $r^{-1.3}$ for $0.2\ m < r < 6\ m$ and r^{-2} for $6\ m < r < 30\ m$. The density of energy flow for the nuclear-active component was determined. The energy of the nuclear component in a circle of radius 30 m for the 3×10^5 particle showers was found to be 3.3×10^{13} eV and for the 10^5 particle showers it was 1×10^{13} eV. The significance of the results is discussed in detail. C.F.Barnaby

3290 ON THE ENERGY SPECTRUM OF NUCLEAR-ACTIVE PARTICLES FROM COSMIC RAYS AT AN ALTITUDE OF 3860 M AND THE ASSOCIATED EXTENSIVE AIR SHOWERS. G.I.Dovzenko, G.T.Zatsepin, E.A.Murzina, S.I.Nikolsky and V.I.Iakovlev.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 134-41.

The energy spectrum was studied in 1955 and 1957. Ionization chambers were used to detect the nuclear-active particles. The integral energy spectrum of the particles was obtained and for the energy range from 10^{12} to 5×10^{13} eV is given by $A E^{-1.5\pm0.1}$. Within the statistical errors of the measurement the value of the exponent did not depend on the thickness of the matter in which the nuclear interactions took place. The absolute intensity of nuclear-active particles having energies greater than 10^{12} eV was $5.5 \pm 0.6\ hr^{-1}\ m^{-2}\ sterad^{-1}$. The absorption length was about 125 gm /cm^2 for these particles. The properties of extensive air showers accompanying nuclear-active particles are discussed. C.F.Barnaby

3291 ABSORPTION OF HIGH-ENERGY NUCLEONS IN THE ATMOSPHERE. L.T.Baradzey, V.I.Rubtsov, V.A.Smorodin, M.V.Soloviev and B.V.Tolkachov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 142-8.

Experiments are described in which a number of ionization chambers was used to measure ionization bursts due to multiplication in lead filters of the electron-photon component of showers. The apparatus was aircraft-carried, and measurements were made at altitudes corresponding to a residual depth of 200 g/cm^2, 310 g/cm^2 and 1020 g/cm^2. The results given include the differential spectra of the electron-photon avalanches, the integral spectra of the nuclear-active component at the different depths and the distribution of energy density near the avalanche axis. In the energy range from $\times 10^{10}$ eV to 2×10^{12} eV and for all the altitudes studied the differential spectra of the electron-photon avalanches approximated to a power law with an exponent of -2.75 ± 0.07. The absorption length of the component generating photons with an energy from 10^{11} to 10^{12} eV was 120 ± 10 g/cm^2. It was found that at altitudes of 200 and 310 g/cm^2 the density of electrons out to a distance of 10 m from the shower axis decreased according to the relationship $r^{-0.7\pm0.1}$. The absorption length for the nuclear-active particles with energies between 10^{11} and 10^{13} eV was about 120 g/cm^2. The spectrum of primary cosmic ray particles in this energy range was of the form $900(E/10^{12})^{-1.5}$ particles $m^{-2}\ hr^{-1}\ sterad^{-1}$. The significance of the results is discussed. C.F.Barnaby

3292 A TRIGGERED SPARK COUNTER TELESCOPE INVESTIGATION ON THE MU-MESON COMPONENT OF EXTENSIVE AIR SHOWERS.
T.E.Cranshaw, J.F.DeBeer and A.G.Parham.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 152-4.

The apparatus used in the experiment consisted of two triggered spark counter μ-meson telescopes, at 500 m separation and operated in conjunction with an extensive air shower array (at Culham, England). The attenuation lengths of air shower μ-mesons were calculated. For mesons between 0 and 200 m from the shower core, a value of 320 gm cm^{-2} was obtained; for mesons between 200 and 400 m from the core the value was 1300 gm cm^{-2}, and for distances greater than 400 m the value was 2700 gm cm^{-2}. The integral momentum distribution in the range 0.3-0.7 BeV was also obtained by observing the number of stopping μ-mesons. The results indicated that the mean energy of μ-meson decreases with increasing distance from the shower core and that the mean energy of μ-mesons in small showers is greater than in large showers. The height of origin of μ-mesons in large cosmic-ray showers is discussed. C.F.Barnaby

3293 INVESTIGATION OF FLUXES OF HIGH-ENERGY MU-MESON COMPONENTS OF EXTENSIVE AIR SHOWERS.
S.N.Vernov, V.I.Tulupov, B.A.Khernov and G.B.Khristiansen.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 158-69.

An experiment designed to investigate the fluxes of the high-energy μ-meson component of extensive air showers is described. From the results it was concluded that the lateral distribution of μ-mesons of energy greater than 10 BeV is substantially affected by the angular distribution of π-mesons in nuclear interaction events. The majority of such μ-mesons are produced at altitudes of 6 to 8 km above sea-level. The dependence of the number of μ-mesons with energy greater than 10 BeV within a circle of radius 25 m or the number of particles in the shower has the form $N^{0.6\pm0.05}$ in the range $N = 10^4$ to 5×10^5. The lateral distribution of μ-mesons with energies exceeding 10 BeV in showers of 2×10^5 particles has the form r^{-n}, where $n = 0.8 \pm 0.2$ for distances of 3 to 10 m from the shower axis. C.F.Barnaby

3294 MULTIPLE PENETRATING PARTICLES AT 50 M.W.E. AND 250 M.W.E. UNDERGROUND.
S.Higashi, S.Mitani, T.Oshio, H.Shibata, K.Watanabe and Y.Watase.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 170-3.

Observations of underground hard showers at depths of 50 and 250 m water equivalent from the top of the atmosphere by the use of a cloud chamber and hodoscope are described. Preliminary results of the frequencies of multiple penetrating particles, the density spectrum and the energy spectrum of μ-mesons in extensive air showers are given. C.F.Barnaby

3295 THE ROLE PLAYED BY FLUCTUATIONS IN THE DEVELOPMENT OF AIR SHOWERS. G.T.Zatsepin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 192-200.

The results obtained from the study of air showers are used to evaluate the characteristics of the nuclear cascade development and to obtain data concerning the nature of the elementary processes of nuclear collisions at super-high energies. C.F.Barnaby

3296 HIGH ENERGY NUCLEAR INTERACTIONS AND EXTENSIVE AIR SHOWERS. S.Hayakawa and N.Ogita.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 220-3.

The irregularity in the energy spectrum of photons at mountain altitudes which has recently been observed to occur at about 10^{12} eV is discussed. It is concluded that the energy spectrum of N-particles cannot completely account for the observations and it is suggested that the explanation may be that only a few pions of energies greater than 10^{12} eV are produced. This possibility is discussed with reference to the fire-ball model of multiple meson production. The nature of possible collision products, other than pions, is also examined. C.F.Barnaby

3297 THEORETICAL ANALYSIS OF EXTENSIVE AIR SHOWERS. H.Fukuda, N.Ogita and A.Ueda.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 224-7.

To obtain information on the elementary nuclear interactions associated with e.a.s. it is necessary to pick out processes which are caused by nuclear particles having energies larger than 10^{12} eV, because in this energy range the characteristics of the elementary interaction are well defined and not subject to large fluctuations for both nucleon–nucleus and pion–nucleus collisions. In view of this two models of multiple particle production are discussed which involve parameters characterizing the dynamical behaviour of the elementary interaction, and an attempt is made to obtain the best values of these parameters to fit the experimental data. C.F.Barnaby

3298 THREE-DIMENSIONAL DEVELOPMENT OF ELECTRON-PHOTON CASCADE SHOWERS.
V.I.Guzhavin and I.P.Ivanenko.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 231-42.

The analysis of experimental results requires that the cascade theory gives the exact behaviour of the functions of angular and lateral distribution of particles around the shower axis. These unknown functions are normally calculated assuming that the energy of the primary particle is infinite. This assumption is not valid near the axis of the shower where the energy of the electrons and photons is close to the energy of the primary particle. A method is suggested which makes it possible to obtain approximate values for the unknown function near the shower axis for any finite value of the primary energy. C.F.Barnaby

3299 DEVELOPMENT OF ELECTRON–PHOTON SHOWERS OF HIGH ENERGY IN CONDENSED MEDIA.
T.G.Volkonskaya, I.P.Ivanenko and G.A.Tin.ofeyev.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 256-76.

This paper outlines the results of some calculations of the longitudinal development of about 300 showers in lead caused by primary electrons of energies of 10^{12} eV and of about 400 showers in photographic emulsion caused by primary photons of energies of 10^{12} eV. Electrons and photons of energies greater than 4×10^{7} eV are considered at depths down to two t-units. C.F.Barnaby

3300 MONTE CARLO CALCULATION OF 10^{11} TO 10^{13} eV CASCADES TAKING INTO ACCOUNT EFFECT OF MEDIUM OR BREMSSTRAHLUNG.
A.A.Varfolomeyev and I.A.Svetlozobov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 277-82.

Calculations are made of electromagnetic cascades in which electrons with energies between 10^{9} and 10^{13} eV are the primary particles. The calculations were based on the non-asymptotic formulae of Bethe and Heitler for the cross-sections of brems-strahlung and pair production, and the Migdal formulae were used to take into account the effect of the medium on bremsstrahlung. Data is also given on the fluctuation of particles in the cascade. C.F.Barnaby

3301 ENERGY DETERMINATION OF ELECTROMAGNETIC CASCADES. P.H.Fowler, D.H.Perkins and K.Pinkau.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 302-5.

For the energy determination of electromagnetic cascades in photographic emulsions it is necessary to measure the number of tracks present at some point in the cascade development. A metho of achieving this is described based on the measurement of the attenuation of light in the emulsion by the grain of the cascade tracks. The experimental arrangement included a densitometer w a slit of 10 μ width which was projected, by the condenser, into the emulsion and the light intensity was measured by a photomultiplier C.F.Barna

3302 COMPARISON BETWEEN THE RESPONSE OF GEIGER AND SCINTILLATION COUNTERS TO THE AIR SHOWER FLUX. C.S.Wallase.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr 7427 of 1960) Vol. II, p. 316-18.

To experimentally determine the relation between the respons of a scintillation counter to the number of charged particles trave ing its sensitive volume, a tray of Geiger counters was included in the scintillation counter array of the Sydney air shower apparatus to determine the charged particle density. This density was com-pared with the "scintillation particle" density computed for the location of the Geiger tray from the responses of the surrounding scintillation counters. The so-called "scintillation particle" densi at any point is an estimate of the response which would have been given by a scintillation counter of the type used, expressed in units of the average response from singly charged relativistic particles incident vertically on the scintillation counter. C.F.Barna

3303 OBSERVATIONS ON COSMIC RAY PENETRATING SHOWERS AT THE ALTITUDE OF 2000 m ABOVE SEA LEVEL. Z.Sh.Manjavidze, N.N.Roinishvili, G.E.Chikovani, A.A.Kozlov, D.M.Kotlarevsky, N.G.Tatalashvili and A.I.Tsintsaba Cosmic Ray Conference, Moscow, 1959, English Edition (see Abst 7427 of 1960) Vol. II, p. 319-22.

The study of the properties of heavy unstable particles was made in a magnetic double cloud chamber operated by cosmic-ra penetrating showers generated in a lead absorber above the cham Among 8700 nuclear interactions, 139 decays of neutral strange particles and 32 decays of charged ones were observed. As a re of the analysis of the neutral particles, 45 were identified as Λ^0-hyperon decays and 38 as θ^0-meson decays. The remaining particles could not be identified either because of the high mome of the primary particle or because of the short track-length of th decay products. Of the positive particles one was interpreted as τ-meson, 7 as K-mesons and 2 as Σ-hyperons. It was not possibl to identify the remainder from the dynamics of the decays. The lifetimes of the Λ^0 and Σ-hyperons are discussed in detail and it is concluded that $\tau(\Lambda^0) = (3.21^{+0.39}_{-0.30}) \times 10^{-10}$ sec and $\tau(\Sigma^{\pm})$ $(0.58^{+0.25}_{-0.12}) \times 10^{-10}$ sec. C.F.Barn

3304 ASYMMETRY OF NEUTRONS FROM A μ-MESON REACTION IN LEAD.
V.V.Cherdyntsev, L.L.Kashkarov, V.M.Ivanenko and E.F.Kudashe Cosmic Ray Conference, Moscow, 1959, English Edition (see Abst 7427 of 1960) Vol. II, p. 327.

The asymmetry of the neutrons resulting from (μ^-, n) types o reaction with respect to the direction of the meson beam was stu using two groups of neutron counters immersed in paraffin at an altitude of 3850 m. The experiments showed that neutrons moving counter to the μ-meson direction were predominant, and the ratio neutrons travelling "upwards" to those travelling "downwards" wa found to be 1.186 ± 0.024. C.F.Barna

3305 SATELLITE OBSERVATIONS OF SOLAR COSMIC RAYS. P.Rothwell and C.McIlwain.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abs 7427 of 1960) Vol. III, p. 14-18.

On three occasions during August, 1958 large increases in the intensity of charged particles outside the Van Allen radiation zone were detected by the Explorer IV satellite, at high magnetic latitudes rather low satellite altitudes (270-650 km), where the two Geiger tubes carried in the satellite normally count only cosmic rays. T counters could detect protons of energies greater than 40 MeV an 30 MeV respectively and electrons of energies greater than about 5 MeV and 3 MeV. The particle fluxes were at least one or two orders of magnitude greater than the normal cosmic ray flux. It suggested that the intensity increases are due to solar protons associated with three large solar flares which occurred during August, 1958. C.F.Barn

3306 MAGNETIC FIELD OF THE OUTER CORPUSCULAR REGION. S.Sh.Dolginov and N.V.Pushkov.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 30-1.

In the magnetic-field measurements made during the flight of ne Soviet cosmic rocket of January 2nd, 1959 the measured field ntensity values were found to deviate substantially from those alculated theoretically by the formulae for resolving the earth's nagnetic field into spherical harmonics. It is shown that the changes bserved in the earth's magnetic field were related to the outer orpuscular region and might be due to the superimposition of the nagnetic field of the corpuscular zone upon that of the earth. A eature of the corpuscular zone field is the presence of two field ntensity maxima, one at 20 000 km and the other at 23 000 km from ne earth's centre. The respective anomalous field intensities in nem were 800 and 200 gammas. C.F.Barnaby

3307 RADIATION OBSERVATIONS WITH SATELLITE 1958 OVER AUSTRALIA.
.J.Herz, K.W.Ogilvie, J.Olley and R.B.White.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 32-40.

A preliminary report is given of the results of the recording f the signals from Sputnik III (1958 δ 2) at the University of Sydney uring July and August 1958. Details of the instrumentation aboard he satellite and the code used did not reach the authors in sufficient ime to allow a complete analysis of the data to be presented, but ome conclusions are drawn about the radiation intensity. A mini- num of radiation intensity was found at a geographic latitude of 5°S. The intensity appears to increase by an order of magnitude hen the latitude changes by about ten degrees on either side of his minimum. It is suggested that this can be interpreted as the ap between the inner and outer radiation belt. The data also suggest time variation in the radiation intensity, a variation of a factor of being mentioned. C.F.Barnaby

3308 ALTITUDE DEPENDENCE AND TIME VARIATION OF THE RADIATION INTENSITY OBSERVED BY U.S. ATELLITE 1958 α. Y.Miyazaki and H.Takeuchi.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 41-5.

Telemetering signals from the US Satellite 1958 α which passed ear Japan were recorded at Tokyo. It is shown that the altitude urve of the counting rate of a Geiger counter showed appreciable ay-to-day variation. The altitude curve seemed to have a maximum etween 350 and 800 km and geomagnetic latitudes 12° and 22°. On ebruary 11, 1958 an enhancement of the radiation intensity was bserved at an altitude of about 1000 km. The neutron intensity of osmic rays observed on the ground showed an increase between 700 and 0800 U.T. on that day. It is suggested that these two vents are closely related. C.F.Barnaby

3309 COMPOSITION OF THE EARTH'S CORPUSCULAR RADIATION AND POSSIBLE MECHANISMS OF ITS ORIGINATION.
.N.Vernov, A.E.Chudakov, A.I.Lebedinsky and I.P.Ivanenko.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 46-9.

Investigations with the Soviet satellites and the cosmic ray ocket yielded the following data of the earth's radiation belt: n the outer zone, the majority of the particles are electrons of 0-100 keV. If the energy spectrum is expressible as $N(>E) \sim E^{-\gamma}$ hen $\gamma \sim 5$. The energy density of the particles is 10^{-8}-10^{-7} erg/cm^3. otal energy of all particles in the outer zone is 10^{21}-10^{22} ergs. The article life in this zone is of the order of weeks or months. In ne inner zone, protons of approximately 100 MeV were discovered. hese protons explained the main portion of ionization in a crystal creened by 1 gm/cm^2 aluminium. The possible mechanisms of rigination of the earth's corpuscular radiation is discussed. C.F.Barnaby

3310 THE NATURE AND ORIGIN OF THE EARTH'S RADIATION BELTS. THEIR RELATION TO UPPER TMOSPHERE DENSITIES AND THEIR GEOPHYSICAL EFFECTS.
.F.Singer.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 50-8.

Theoretical calculations of the density of neutral particles in ne exosphere are discussed, and methods of obtaining the hydrogen oncentration as a function of altitude are described. The impli- ations of the experimental observation of a maximum for the inner radiation belt at an altitude of about half an earth radius are examined with particular reference to the auroral belt and the magnetic storm belt. An account is given of geophysical effects. C.F.Barnaby

3311 ON FAST CORPUSCULES OF THE UPPER ATMOSPHERE.
V.I.Krassovsky, I.S.Shklovsky, G.I.Galperin and E.M.Svetlitsky.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 59-63.

The results obtained from an experiment for the direct discovery of soft electrons in the upper atmosphere is described. The properties of these electrons are discussed and possible mechanisms of generation are suggested. C.F.Barnaby

3312 TEMPORARY CAPTURE OF COSMIC RAY PARTICLES AND THEIR CONTRIBUTION TO THE HIGH INTENSITY BELTS. B.Gall and J.Lifshitz.
Cosmic Ray Conference, Moscow, 1959, English edition (see Abstr. 7427 of 1960) Vol.III, p. 64-73.

This paper is concerned with the temporary trapping of charged particles in the vicinity of unstable periodic orbits and their possible contribution to the earth's radiation belts. The contribution of both primary and secondary cosmic ray particles is considered. C.F.Barnaby

3313 ON THE NATURE OF THE EXTERNAL RADIATION BELT OF THE EARTH. G.Askaryan.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 81-5.

An attempt is made to explain the observations of the earth's radiation belt taking into account the suppression of the transverse conductivity of the plasma stream from the sun under the influence of the magnetic fields. In earlier theories, no account was taken of this and, therefore, they are less convincing. C.F.Barnaby

3314 OBSERVATIONS ON THE HELIUM NUCLEI OF THE COSMIC RADIATION. P.J.Duke.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 89-91.

A stack of Ilford G5 emulsions flown over Minnesota (geomagnetic latitude 55°N) at a height of 117 000 ft in September 1956 indicated a total flux of primary cosmic ray alpha particles of 240 ± 26 particles m^2 sec^{-1} sterad^{-1}. The differential energy spectrum (dJ/dE) below 1000 MeV/nucleon was also determined and an empirical law is suggested

$$\frac{dJ}{dE} \propto \frac{1 - \exp(-125\,E^{3.5})}{(1 + E)^{2.5}}$$

C.F.Barnaby

3315 OBSERVATIONS ON THE HEAVY NUCLEI OF THE COSMIC RADIATION AT VERY LOW ENERGIES.
D.Evans.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 92-5.

Preliminary results are given of an experiment designed to investigate the inverse correlation between the alpha particle fluxes at a fixed geomagnetic latitude (55°N) and sunspot number. C.F.Barnaby

3316 THE PRIMARY COSMIC RADIATION AT PRINCE ALBERT, CANADA. H.Aizu, Y.Fujimoto, S.Hasegawa, M.Koshiba, I.Mito, J.Nichimura, K.Yokoi and M.Schein.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 96-101.

This paper is a resumé of four papers entitled "The Primary Cosmic Radiation at Prince Albert, Canada, Paper I: Carbon, Nitrogen and Oxygen; Paper II: Heavier Elements of $Z \geq 9$; Paper III: Lithium, beryllium and boron; Paper IV: Alpha particles";(see Abstr. 1338 of 1960 and following abstract). The aim of the experimental work was to obtain a picture of the primary cosmic radiation at low energies and for this purpose a stack of Ilford G5 emulsion was flown for 8 hours at an altitude of 120 000 ft at 62°N geomagnetic latitude. A table of abundancies of elements at the top of the atmosphere is given. The abundancies observed in the low energy region are in general agreement with those of higher energies reported previously. The relative over-abundance of the heavy elements of $Z \geq 9$ with respect to CNO and the anomaly in the C:N:O ratio observed in the high energy region are also established in the low energy region. The upper limit for the amount of anti-matter in the primary radiation is estimated to be 0.1%. C.F.Barnaby

3317 HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION AT PRINCE ALBERT, CANADA. II. H.Aizu, Y.Fujimoto, S.Hasegawa, M.Koshiba, I.Mito, J.Nishimura, K.Yokoi and M.Schein.
Phys. Rev. (USA), Vol. 121, No. 4, 1206-18 (Feb. 15, 1961).

For Pt I, see (Abstr. 1338 of 1960). The investigation of the low-energy primary cosmic radiation was extended to include the heavier elements of $Z > 9$; the light elements Li, Be, and B; and α-particles. The results of previous work on carbon, nitrogen, and oxygen are also confirmed with better statistics. The energy spectra of all these components show a general similarity in shape. A possible deviation of the light-element spectrum from this similarity is discussed. The abundances of various elements in the low-energy region of 200 to 700 MeV per nucleon are essentially the same as observed in the higher-energy region.

3318 THE ENERGY SPECTRUM OF HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION.
S.Biswas, P.J.Lavakare, K.A.Neelakantan and P.G.Shukla.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 102-11.

In this investigation the energies of heavy primary nuclei in nuclear emulsions are determined by the "knock-on" electron method. The conditions for reliable determination of the primary energy are discussed in detail and it is shown that the values obtained from this technique agree well with those determined by other established methods. The frequency of useful "knock-on" electrons in nuclear emulsions for primary particles of charge $Z \geq 5$ is sufficient for systematic measurements of energies.
C.F.Barnaby

3319 THE INTERACTION OF VERY HEAVY COSMIC RAY NUCLEI. C.J.Waddington.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 112-14.

The previous estimates of the abundances of the $M(6 \leq Z \leq 9)$ and $H(Z \geq 10)$ nuclei suffer from a considerable error (Abstr. 7146 of 1958) due to the assumption that a diffusion equation may be established for the propagation of these nuclei through the atmosphere, and separating the nuclei into charged groups. This paper describes an attempt made to improve the diffusion model by breaking the H group up into H nuclei ($10 \leq Z \leq 19$) and VH nuclei ($Z \geq 20$). Diffusion parameters for these two groups are estimated — from the published data for the H group and from experimental data for the VH group. The latter was obtained by analysing 111 interactions of VH nuclei in two stacks of emulsion — one flown over Northern Italy at about 100 000 ft and the other over Texas at about 130 000 ft.
C.F.Barnaby

3320 INTENSITY OF PRIMARY HELIUM AT GEOMAGNETIC LATITUDE 3°N.
B.Hildebrand, F.W.O'Dell, M.M.Shapiro and B.Stiller.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 115-17.

The results are given of an experiment performed in February 1957 to evaluate the intensity of the primary cosmic-ray helium in the vicinity of the geomagnetic equator. An Ilford G5 emulsion stack was flown by balloon to 103 000 ft at a geomagnetic latitude of 3°N. For a zenith angle interval of 0-30° the helium flux at the balloon altitude (10 g/cm^2) was 13.0 ± 1.7 peters (particles m^{-2} sec^{-1} sterad^{-1}) which corresponded to a flux at the top of the atmosphere of 15.7 ± 2.2 peters. The corresponding fluxes for an angle interval of 30-60° were 8.0 ± 1.2 and 10.0 ± 1.7 peters respectively.
C.F.Barnaby

3321 ABUNDANCE RATIO OF LITHIUM, BERYLLIUM AND BORON TO THE HEAVIER PRIMARY NUCLEI IN THE COSMIC RADIATION. F.W.O'Dell, M.M.Shapiro and B.Stiller
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 118-22.

This is an initial report giving the experimental details of an attempt to discover if the cosmic radiation incident at the top of the atmosphere contains an appreciable fraction of lithium, beryllium and boron. A stack of emulsion was flown in a remarkably level flight at an altitude corresponding to 2.7 g/cm^2 atmospheric depth. The advantages of this experiment over previous ones are: (1) the stack was close to the top of the atmosphere; (2) the detection efficiency was very high; (3) the charge resolution was excellent; (4) the statistics were superior. The result of the track analysis will be published at a later date.
C.F.Barnaby

3322 INVESTIGATIONS OF HIGH-ENERGY HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION CLOSE TO THE GEOMAGNETIC EQUATOR (GUAM, MARIANAS ISLANDS).
D.M.Haskin, P.L.Jain, E.Lohrmann, M.Schein and M.Teicher.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 123-4.

The analysis of 540 tracks of high-energy heavy nuclei in a large stack of nuclear emulsion exposed to the cosmic radiation a 102 000 ft near geomagnetic equator is described. The energy spectrum of heavy nuclei between 7 BeV/nucleon and 100 BeV/nucleon was found to be given by $N(>E) \sim E^{-1.6 \pm 0.15}$ where E is the total energy per nucleon. It was found that the interaction mean free paths were in reasonable agreement with the results obtained at lower energies indicating that the mean free path is independent of energy. Meson production by high-energy heavy primaries and α-particles is discussed. At an average energy of 10 BeV/nucleon and 40 BeV/nucleon the average numbers of charged mesons produced by α-particle interactions with emulsion nuclei were 4.6 and 8.2 respectively. After a search for anti-nuclei it is concluded that in our galaxy the amount of anti-matter existing in the form of low energy cosmic radiation must be less than 1%.
C.F.Barnaby

3323 ON THE CHARGE SPECTRUM OF HEAVY PRIMARIES.
B.Waldeskog, O.Mathiesen and K.Kristiansson.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 125-8.

The results are given of an analysis of 150 tracks in a batch of Ilford G5 emulsions exposed in Texas at an altitude of 29 000 m. It is shown that; (1) boron is quite abundant, which agrees with the fact that its production cross-section is appreciable; (2) there is more carbon than oxygen at 15 g/cm^2 and it is indicated that they are about equally abundant at the top of the atmosphere; (3) there is only 25% as much nitrogen as oxygen; (4) with the exception of boron even charges are at least 8-10 times as common as odd charges; (5) magnesium is the most common of the heavier elements; (6) there is about as much chromium as iron; and (7) the number of particles of atomic numbers 17-21 is small.
C.F.Barnaby

3324 ENERGY SPECTRUM OF PRIMARY COSMIC PARTICLES.
A.N.Charakhchyan and T.N.Charakhchyan.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 129-35.

This paper describes the results of investigations of the electron component of the cosmic radiation in the upper layers of the atmosphere.
C.F.Barnaby

3325 THE POINT SOURCE OF COSMIC RAYS AND A VARIABLE STAR "ω-ORIONIS". T.Murayama.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 140-2.

The results of Sekido et al. (Abstr. 5857 of 1959) who used a narrow-angle telescope to indicate a point source of high-energy cosmic rays are interpreted by assuming that the observed cosmic rays are produced by the collision of air nuclei with the high-energy gamma-rays incident on the earth.
C.F.Barnaby

3326 ABSENCE OF SOLAR AND SIDEREAL TIME VARIATIONS OF E.A.S. DURING 1958.
J.Delvaille, F.Kendziorski and K.Greisen.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 143-9.

Multiple coincidences between scintillations at spacings of 10 m to 600 m were used to select showers of median size varying from 10^4 to 1.5×10^7 electrons. For each time interval of $\frac{1}{2}$ mon an analysis was made for barometric and temperature coefficients and for the Fourier amplitudes of the first two harmonics in the daily time variation. The data extended over 24 periods, from December 1951 to December 1958. An analysis of the Fourier components in solar, sidereal and anti-sidereal time showed no significant time variations for showers of less than 10^8 electrons. Forty-nine larger showers were analysed for solar time variation and the amplitudes of the first and second harmonics were both found to be less than the expected accidental value. The probable phase of the second harmonic was 4.6 hours. The largest shower recorded contained about 3×10^9 particles.
C.F.Barnaby

3327 AN EXPERIMENT FOR MEASURING THE CHEMICAL COMPOSITION OF PRIMARIES IN THE AIR SHOWER EGION.
T.Murthy, B.Peters, P.V.Ramanamurthy and B.V.Shreekanthan.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 27 of 1960) Vol. III, p. 150-2.

An experiment to determine the charge composition of the imary radiation beyond the emulsion region (10^{15}-10^{16} eV) is scribed. The experiment was based on the assumptions that at very igh energy each nucleon belonging to the primary particle acts as h independent unit and that in each of the approximately 16 collisions, hich nucleons suffer in traversing the atmosphere, they lose a comratively small fraction of their energy and emerge still carrying bout 70% of the incident energy. The most important component of e apparatus was a set of two large-area spark counters in coicidence. At the time of the conference it was only possible to ate that a large fraction of all shower cores contain several high nergy nucleons of comparable energy. C.F.Barnaby

3328 CHEMICAL COMPOSITION OF COSMIC RAYS AND ORIGIN OF ELEMENTS.
Hayakawa, C.Hayashi, K.Ito, J.Jugaku, M.Nishida and N.Ohyama.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 171-80.

In this paper the "rapid process" which is supposed to take lace in the earliest stage of a supernova explosion is discussed nd the question of whether the cosmic-ray abundances can be xplained in terms of it is investigated. C.F.Barnaby

3329 INTERPRETATION OF THE ENERGY SPECTRA OF HEAVY PRIMARY COSMIC RAYS.
Hayakawa, M.Koshiba and Y.Terashima.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 181-92.

Discusses information on acceleration mechanisms given by xperimentally determined energy spectra of the various components of the primary cosmic radiation. C.F.Barnaby

3330 ACHIEVEMENTS IN RADIOASTRONOMY AND RADIOASTRONOMICAL THEORY OF THE ORIGIN OF COSMIC RAYS. I.S.Shklovsky.
osmic Ray Conference, Moscow, 1959, English Edition (see bstr. 7427 of 1960) Vol. III, p. 205-10.

The aim is to make more exact the radioastronomical theory f the origin of cosmic rays using the latest results and developments in radioastronomy. C.F.Barnaby

3331 A POSSIBLE SOLAR PARTICLES ACCELERATION MECHANISM. L.Davis, Jr.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. III, p. 226-7.

3332 ON THE ACCELERATION OF COSMIC RAYS DURING THE EARLY PART OF THE EVOLUTION OF OUR GALAXY. L.Biermann and L.Davis.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 228-32

The suggestion that the cosmic rays are stored in the halo and disk rather than just in the disk of the Galaxy is now widely accepted. This leads to a great increase in the estimate of the mean age of the cosmic rays. The authors have found that a reasonable case could be made for taking this age to be about 5×10^9 years and have therefore suggested that a useful tentative hypothesis would be that the cosmic rays originated relatively early in the evolution of the Galaxy and have been stored, mainly in the halo,ever since. It was also found that at that early stage conditions were likely to be much more favourable than now for almost all possible acceleration mechanisms, and that they were particularly favourable for the Fermi statistical mechanism. The current status of this hypothesis is summarized. C.F.Barnaby

3333 ON THE QUESTION OF A UNIFIED PROCEDURE FOR INTRODUCING CORRECTIONS FOR METEOROLOGICAL EFFECTS INTO DATA OBTAINED BY MEANS OF MESON TELESCOPES AND IONIZATION CHAMBERS. L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 21-4.

The problem of a unified procedure for applying corrections for meteorological effects to data obtained by meson telescopes and ionization chambers is discussed with the aim of resolving the fundamental question of which of the existing methods could be used as a basis for such a unified procedure. It is concluded that the integral method can serve as a basis for the suggested procedure but future refinements and improvements are forseen. C.F.Barnaby

3334 ON THE CORRECTION OF MESON INTENSITIES FOR ATMOSPHERIC TEMPERATURES. A.Ehmert.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p.25-9.

A detailed equation is deduced for the calculations of the meson number which gives good agreement with experimental results. C.F.Barnaby

3335 ATMOSPHERIC COEFFICIENTS AND SOLAR DAILY VARIATION OF THE COSMIC RADIATION MEASURED 18 m UNDERGROUND.
T.Sandor, A.Samogyi and F.Telbisz.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 30-3.

A Geiger-counter telescope was operated at a depth of 18 m (about 40 m water equivalent) underground at Budapest (47.5° N and 18.9° E, 410 m a.s.l.) and the variations is cosmic ray intensities between 20th February 1958 and 31st March 1959 recorded. Results are given showing the monthly total barometric coefficient, the absorption coefficient and the partial regression coefficient of the height of the 200 mb isobaric level. These coefficients averaged over 13 months were $-0.86 \pm 0.01\%$ cm^{-1} Hg, $-0.80 \pm 0.01\%$ cm^{-1} Hg and $-0.83 \pm 0.04\%$ km^{-1} respectively. The coefficients showed a much greater spread than would be expected on the basis of their statistical errors. The amplitude and phase of the solar daily variation is calculated for each monthly period. The amplitude and the time of the maximum calculated for the 12 monthly period were $0.64 \pm 0.07\%$ and 1310 ± 0030 UT respectively. There was a significant difference between the time of the maximum between February and July (1130 ±0020 UT) and between August and January (1650 ± ± 0030 UT), the amplitudes being $0.09 \pm 0.01\%$ and $0.07 \pm 0.01\%$ respectively. C.F.Barnaby

3336 ANNUAL VARIATIONS OF COSMIC-RAY INTENSITY AND TEMPERATURE CORRECTIONS. E.S.Glokova.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 35.

The use of the Dorman method for calculating the temperature corrections to cosmic ray intensity measurements is discussed. It is pointed out that care must be exercised due to the fact that calculated values of the density of the temperature coefficients depend sharply on the exponent in the equation for the spectrum of the generation of π-mesons. C.F.Barnaby

3337 ON THE METEOROLOGICAL EFFECTS OF THE SOFT COMPONENT OF COSMIC RADIATION. Ya.L.Blokh.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 37-40.

The aim of this paper is to verify the theory of the atmospheric effects of the soft component, developed by Dorman and Feinberg (Abstr. 6023 of 1958), from the data of a continuous recording cosmic-ray telescope operated at Moscow between July 1957 and February 1959. C.F.Barnaby

3338 ON THE THEORY OF SECOND ORDER METEOROLOGICAL EFFECTS OF COSMIC RADIATION.
L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 41-3.

It is pointed out that although the integral method of computing meteorological corrections for cosmic ray data is sufficiently accurate for most practical purposes it is sometimes necessary, for example when comparing differences in cosmic-ray variations at different stations, to obtain greater precision. For this purpose an equation is deduced giving the second approximation to the integral method. C.F.Barnaby

3339 ON THE VARIABILITY OF THE METEOROLOGICAL COEFFICIENTS OF THE HARD COMPONENT OF COSMIC RADIATION. N.S.Kaminer.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 44-6.

This paper contains the results of calculations of the dependence of the barometric and temperature coefficients of the hard com-

ponent on the shield thickness over the instrument measuring the cosmic radiation, on the altitude of the station above sea-level, and on the temperature of the atmosphere for particles incident vertically. C.F.Barnaby

3340 ON THE RELATIONSHIP BETWEEN THE PRIMARY AND SECONDARY COMPONENTS OF COSMIC RADIATION. A.I.Kuzmin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p.48-9.

In view of the fact that the coupling coefficients of the primary and secondary components of cosmic radiation, obtained by Dorman and Feinberg (Abstr. 6023 of 1958), in the energy range > 15 BeV are not reliable, the primary variations are determined by means of two, substantially different, coupling coefficients. C.F.Barnaby

3341 THE STUDY OF COSMIC RAY VARIATIONS WITH NUCLEAR EMULSIONS. C.J.Waddington.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 85-7.

The use of nuclear emulsions in studying temporal variations of the cosmic radiation has hitherto been confined to investigations of the α-particle component. Such investigations involve several man-months of effort for each exposure so that it has not been possible to follow the temporal fluctuations in detail. Because of this a new parameter — the rate of production of particles observed to come to rest, or end, in the emulsions while they are at high altitudes — has been investigated. This parameter is related to the primary cosmic ray flux and can be determined in a few man-hours of work. Further it is shown that the use of the parameter makes it unnecessary to have exposures of very great duration and significant results can be obtained from a few grams of emulsion exposed in meteorological balloons. C.F.Barnaby

3342 TWO UNUSUAL EVENTS AT HIGH ALTITUDES. H.V.Neher and H.R.Anderson.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 101-13.

Two unusual increases in ionizing radiation at balloon altitudes are discussed. The first event took place on July 28, 1957, at Bismarck, North Dakota. The radiation recorded was not geomagnetic field limited but was probably due to protons down to energies of 100 MeV. It is suggested that these particles either leaked through the northern ends of the Van Allen belts or were injection particles from the sun. The second event also took place at Bismarck, on October 16, 1958. This was a sudden burst of radiation that lasted for about 15 minutes. This increase was not of a solar flare type and seems not to have been accompanied by any appreciable ionospheric or magnetic disturbance. C.F.Barnaby

3343 ON THE ENERGY SPECTRUM AND DURATION, ON EARTH, OF A COSMIC RAY INTENSITY INCREASE CAUSED BY A SHOCK WAVE AND ALBEDO FROM THE FRONT MAGNETISED FACE OF A CORPUSCULAR STREAM. L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 134-41.

3344 N-COMPONENT INTENSITY FROM JULY 1957 TO JULY 1958 AND GEOMAGNETIC AND SOLAR ACTIVITY. F.Bachelet, P.Balata, A.M.Conforto and G.Marini.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 150-1.

The variations of the low energy nucleonic component of the cosmic radiation were measured in Rome between July, 1957 and July, 1958. Preliminary results are given of an analysis of the time sequence of both the cosmic radiation variation and the occurrence of magnetic storms. The correlation between these two classes of phenomena is discussed. C.F.Barnaby

3345 DETERMINING THE CHARACTER OF EARTH-ENVELOPMENT BY A STREAM, AND THE PROPERTIES OF CORPUSCULAR STREAMS FROM COSMIC-RAY VARIATIONS DURING DIFFERENT MAGNETIC STORMS.
Ya.L.Blokh, L.I.Dorman and N.S.Kaminer.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 155-66.

In this paper the intensity variations (observed at stations on a world-wide network) of the hard and neutron components of cosmic radiation during various magnetic storms covering the period from 1954 to 1959 (a total of about 40 cases) are investigated. In each case an appropriate profile of intensity variations is found and compared with the theoretically expected value using various assumptions concerning: the velocities of the corpuscular streams carrying frozen magnetic fields; the nature of envelopment of the earth by these streams; and the structure of the field. In this way an interpretation of each individual case is attempted. Statistical regularities are found in the velocities of the streams and the way they envelop the earth for magnetic storms of different types and intensities C.F.Barnaby

3346 ELECTROMAGNETIC CONDITIONS IN INTERPLANETARY SPACE ACCORDING TO THE DATA OF COSMIC-RAY VARIATIONS DURING THE PERIOD FROM AUGUST 20 TO SEPTEMBER 10, 1957.
Ya.L.Blokh, E.S.Glokova, L.I.Dorman and G.I.Inozemtseva.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, P. 167-72.

The experimental results of the cosmic-ray intensity variation during the period from August 29th to September 10th, 1957, obtained by 50 cosmic-ray stations in a world-wide network are used to analyse the properties of the corpuscular streams that generated the variations. C.F.Barnaby

3347 THE EFFECT OF INTENSITY-INCREASE OF COSMIC RADIATION PRIOR TO MAGNETIC STORMS.
Ya.L.Blokh, L.I.Dorman and N.S.Kaminer.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 173-90.

The experimental data covering the period from August 20th to September 10th, 1957 showed that at the majority of stations measuring the intensity of the cosmic radiation there was a slight increase (up to 3%) in intensity immediately preceding the sudden commencement of the magnetic storm of August 29th, 1957. The mechanism capable of giving rise to this effect is discussed and an analysis is made of the increase effect of about 40 magnetic storms. C.F.Barnaby

3348 LOCAL AND WORLDWIDE C.R. INTENSITY VARIATIONS DURING GEOMAGNETIC STORMS AND SMALL GEOMAGNETIC DISTURBANCES. R.L.Chasson and K.Maeda.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 191-6.

Results are given of cosmic ray intensity measurements carried out at several stations at 50° N geomagnetic latitude. The variations observed are discussed and the recurrence characteristics of cosmic-ray behaviour during periods of geomagnetic storminess are investigated. C.F.Barnaby

3349 TIME VARIATIONS OF COSMIC-RAY INTENSITY UNDERGROUND AT LOW LATITUDE.
V.H.Regener and J.F.Kenney.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 216-18.

A vertical narrow angle μ-meson telescope was operated underground at Chacaltaya, Bolivia at a depth of 30 m water equivalent. The counting rate was 5000 three-fold coincidences per hour. The high counting rate made it possible to carry out a harmonic analysis of the data obtained each day and results are given for 68 days of counting between January 17 and May 30, 1959. The variation of intensity due to the magnetic storm of May 11, 1959 is discussed. C.F.Barnaby

3350 THE COSMIC RAYS "PREDECREASE" (PREBAISSE) IN THE MAXIMUM SOLAR ACTIVITY PERIOD (APRIL 19[illegible] DECEMBER 1958). J.P.Legrand.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 219-27.

The small decrease in cosmic-ray intensity (1-3%) observed by the author to occur 3 to 18 days before several big cosmic-ray storms is discussed. An attempt is made to establish the correlations between these decreases and solar and geomagnetic processes. C.F.Barnaby

3351 ANISOTROPY AND THE ORIGIN OF THE SOLAR DAILY VARIATION OF COSMIC RAY INTENSITY.
V.Sarabhai, S.P.Duggal, U.R.Rao, H.Razdan and T.S.G.Sastry.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 231-9.

Results are given of a series of experiments conducted between 1952 and 1959 at three stations near the geomagnetic equator along

the 75°E meridian. From these results the nature of the change of the observed solar daily variation and how it is related to the cycle of solar activity is examined. Also the energy dependence of the variations of cosmic ray intensity and anisotropy, and under what conditions the solar daily variation can be associated with an anisotropy outside the influence of the geomagnetic field are discussed. C.F.Barnaby

3352 INTENSITY VARIATIONS OF COSMIC RAYS UNDERGROUND. A.I.Kuzmin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 252-7.

Details are given of the measurement of the intensity of the hard component of the cosmic radiation since 1957 at Yakutsk (62°N, 129°43' E) at depths of 7, 20 and 60 m water equivalent. The observed variations of intensity are discussed in detail and it is concluded that the meteorological effects of the intensity in the hard component are in agreement with the concept of a two-meson generation scheme of the hard component in the atmosphere. The solar-diurnal variations, the 27 day variations and the depressed cosmic-ray intensity during magnetic storms are also discussed. C.F.Barnaby

3353 A LUNAR COSMIC RAY INTENSITY VARIATION. E.Bagge and O.Binder.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 262-70.

The reasons for suggesting a lunar-day periodic time-variation of cosmic-ray intensity are discussed. To investigate this time variation, cosmic-ray intensity measurements obtained from 1 July 1957 to 15 July 1958 are analysed. It is shown that the cosmic-ray intensity varies with the local position of the moon for an observer in Kiel, W.Germany, in such a way that the cosmic-ray intensity is decreasing while the moon is culminating and reaching a maximum between 15 and 21 hours after upper culmination. C.F.Barnaby

3354 CERTAIN EXPERIMENTAL RESULTS IN STUDIES OF COSMIC-RAY VARIATIONS AT HIGH AND MIDDLE LATITUDES. E.S.Glokova and O.I.Inozemtseva.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 293-300.

This paper includes a study of the peculiarities of variations in high latitudes as compared with moderate latitudes at stations situated above the knee of the latitude effect of the cosmic radiation. A comparison is made between the intensity variations of the hard component at the antarctic station Mirny and at Moscow. The results of studies of the seasonal, 24 hour variations and 27 day variations are given. C.F.Barnaby

3355 RECURRENT VARIATIONS OF COSMIC RAYS DURING SOLAR MAXIMA AND THEIR RELATION WITH OPTICAL ACTIVITY: SUNSPOTS AND CORONA. A.Freon.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 301-4.

The observation that the recurrent intensity variation of cosmic-rays shows a maximum of amplitude and stability in a period of maximum solar activity was investigated with two neutron monitors: one at the observatory of Pic-du-Midi, altitude 2680 m, geomagnetic latitude 46°N; and the other at Port-aux-Francais, sea-level, geomagnetic latitude 57.2°S. The data used are the daily mean values of the intensity from October, 1956 to January, 1959. An attempt is made to relate the observed variations with solar activity. C.F.Barnaby

3356 INDEX OF COSMIC RAY ACTIVITY AND ITS CONNECTION WITH MAGNETIC, IONOSPHERIC AND SOLAR ACTIVITY. K.K.Fedchenko.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 305-7.

The possibility of introducing some measure, or index, of the fluctuations in cosmic ray intensity within some period of time is discussed. The connection between such an index of cosmic ray activity with magnetic and ionospheric disturbances and solar activity is investigated. C.F.Barnaby

3357 THE COSMIC RAY TIME VARIATIONS AND THE SOLAR MAGNETIC FIELD.
H.Elliot, R.J.Hynds, J.J.Quenby and G.J.Wenk.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 311-19.

This report gives a brief survey of work done at Imperial College, London on the interpretation of cosmic ray intensity measurement. The topics discussed are: geomagnetic cut-off rigidities; the differential response functions which relate the response of a particular detector to the primary spectrum; the primary spectrum variations; the spectral response of the intensity modulating mechanism; and the cosmic ray intensity modulation by a solar magnetic field. C.F.Barnaby

3358 ON THE THEORY OF THE MODULATION OF COSMIC RAYS BY THE SOLAR WIND. L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p 320-9.

Certain modifications of Parker's theory of cosmic ray intensity modulation by the solar wind are suggested. C.F.Barnaby

3359 THE SECULAR VARIATION OF COSMIC-RAY LATITUDE EFFECT. S.Fukushima and M.Kodama.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 330-3.

A latitude survey of the cosmic-ray nucleonic component at sea-level was carried out from Japan to the Antarctic during the period from November 1958 to April 1959. The course of the ship was almost the same as an earlier survey (see Abstr. 15489 of 1960). The results of the survey are given and it is shown that if the differential spectrum of the primary cosmic rays is expressible in the form $KE^{-\gamma}$ then γ is 2.3 (the value obtained in the first survey was 2.2). The observed cosmic ray intensity variations are discussed. C.F.Barnaby

3360 SOME GEOPHYSICAL ASPECTS OF COSMIC RAYS. A.E.Sandström.
Amer. J. Phys., Vol. 29, No. 3, 187-97 (March, 1961).

After some introductory remarks concerning the primary and secondary cosmic radiation, there follows a section dealing with intensity variations resulting from atmospheric effects. The following two sections deal with the normal effect of the terrestrial magnetic field on the primary cosmic-ray particles. Another section deals with intensity variations (Forbush decreases) correlated to magnetic storms (sudden commencements). The main part of the paper is devoted to the daily variations and an experiment during the IGY on the diurnal variation of the cosmic rays.

3361 A GOLD-SILICON SURFACE-BARRIER PROTON RANGE TELESCOPE.
R.Takaki, M.Perkins and A.Tuzzolino.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 64-72 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

The Au–Si semiconductor particle detector affords a convenient means for studying low-energy cosmic-ray proton spectra. Small size, stability, energy resolution and relative insensitivity to β- and γ-radiation suggest their use on space vehicles. An apparatus is described which employs two detectors forming a proton range telescope. It provides information on the proton flux lying in the energy intervals from $\cong$ 0.5 to 5 MeV and from 5 to 10 MeV, without the use of pulse-height analysis. This principle can be extended to additional energy intervals.

3362 SOLAR MODULATION OF PRIMARY COSMIC RAYS. Y.Terashima.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1138-50 (June, 1960).

The solar modulation of cosmic rays is accounted for in terms of a combined model, for which disordered as well as ordered magnetic fields are responsible. These magnetic fields are considered to be of solar origin. The diffusion region of disordered magnetic fields is assumed to extend widely over the solar system and takes part in the modulation of the low-energy part of primary cosmic rays. Special attention is given to the interpretation of the characteristic shape of the low-energy spectra (Abstr. 1338 of 1960) common to all heavy primary cosmic rays. The eleven-year variations are ascribed to the superposition effect of ordered magnetic fields distributed near the earth's orbit. The diurnal variations are shown to be a direct consequence of the present model. The arguments are based upon the assumption of two kinds of solar streams: the continuously ejected streams and the more intense ones produced by solar eruptions. A quantitative estimate is made of the physical parameters in the present model.

3363 COSMIC-RAY NEUTRON INCREASE FROM A FLARE ON THE FAR SIDE OF THE SUN.
H.Carmichael, J.F.Steljes, D.C.Rose and B.G.Wilson.
Phys. Rev. Letters (USA), Vol. 6, No. 2, 49-50 (Jan. 15, 1961).

Attention is drawn to a third injection of solar cosmic rays which occurred after the two bursts on Nov. 12 and 15, 1960. The increase, observed at Deep River, Sulphur Mountain, Ottawa, and Churchill, started at 2055 ± 10 U.T. on Nov. 20, 1960. It is postulated that it was due to a flare occurring 120° W of the centre of the solar disk, and it is suggested that it was produced by solar protons. E.W.Kellermann

3364 THE STUDY OF HIGH-ENERGY γ-RAYS PRODUCED BY COSMIC RADIATION AT 40 000 FEET. I. EXPERIMENTAL DISPOSITION, AND DETERMINATION OF ENERGY AND NATURE OF ELECTROMAGNETIC CASCADES.
J.G.Duthie, C.M.Fisher, P.H.Fowler, A.Kaddoura, D.H.Perkins and K.Pinkau.
Phil. Mag. (GB), Vol. 6, 89-111 (Jan., 1961).

Two composite stacks of alternate sheets of nuclear emulsion were used to investigate electromagnetic cascades in the cosmic radiation. The stacks were exposed in a BOAC Comet aircraft for a total of 1400 hours at about 38 000 ft. Approximately 600 cascades were observed, and a sample of these was classified as arising either from γ-rays incident from the atmosphere or as a result of nuclear interactions in the stack. The zenith-angle distribution of the cascades was used to determine the attenuation length of the radiation producing the cascades. The number of electron tracks in the cascades was determined by a photometric method, and the relation between the photometric density and the cascade energy was established for the two types of cascade.

3365 THE STUDY OF HIGH-ENERGY γ-RAYS PRODUCED BY COSMIC RADIATION AT 40 000 FEET. II. THE ENERGY SPECTRUM OF CASCADES AND ITS INTERPRETATION.
J.G.Duthie, C.M.Fisher, P.H.Fowler, A.Kaddoura, D.H.Perkins, K.Pinkau and W.Wolter.
Phil. Mag. (GB), Vol. 6, 113-31 (Jan., 1961).

The results of the measurement of the density of electromagnetic cascades described in Pt I (see preceding abstract) are discussed. For events initiated by single γ-rays from the atmosphere it is found that the integral spectrum of cascade energy may be represented by a power law with a exponent -3.0 ± 0.20 for the range 1200-8000 BeV. The corresponding exponent for cascades associated with local nuclear interactions is -2.9 ± 0.2 in the same energy range. The γ-ray spectrum may be used to calculate the pion spectrum in the atmosphere and this is compared with that deduced from measurements on μ-mesons at sea-level or underground. Reasons for the resulting discrepancies are discussed. The flux of cascades associated with local nuclear events when compared with the nuclear flux deduced from measurements on extensive air showers yields values for the fractional energy, K_π, radiated as pions in collisions of nucleons in the energy range 10 000-100 000 BeV. It is found that K_π decreases strongly with increasing primary energy. An upper limit to K_π is deduced from observations on the longitudinal development of these cascades.

3366 SOME FEATURES OF EXTENSIVE AIR SHOWERS OF PRIMARY ENERGY $\geq 10^{14}$ eV.
B.N.Srivastava and A.N.Suri.
J. sci. industr. Res. (India), Vol. 19B, No. 6, 221-2 (June, 1960).

A study of the time variations of very high energy extensive air showers. S.J.Goldsack

3367 SPATIAL DISTRIBUTION OF HIGH-ENERGY NUCLEAR-ACTIVE PARTICLES IN THE CORE OF EXTENSIVE AIR SHOWERS. A.A.Emel'yanov and O.I.Dovzhenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 814-21 (Sept., 1960).
In Russian.

Considers spatial distribution of high-energy nuclear-active particles in the core of extensive atmospheric showers. The r.m.s radius for nuclear-active particles with energies $\geq 5 \times 10^{11}$ eV is computed from the angular distribution of secondary particles emitted in multiple production processes, as predicted by the Landau hydrodynamic theory. It is shown that the magnitude of the r.m.s. radius is determined not only by the angles of emission of the secondary particles during multiple production, but also by diffraction scattering of the nuclear-active particles on nuclei of atmospheric atoms. [English translation in: Soviet Physics—JETP (USA)].

3368 OBSERVATIONS OF EXTENSIVE AIR SHOWERS NEA THE MAXIMUM OF THEIR LONGITUDINAL DEVELC MENT. J.Hersil, I.Escobar, D.Scott, G.Clark and S.Olbert.
Phys. Rev. Letters (USA), Vol. 5, No. 1, 22-3 (Jan. 1, 1961).

The densities of extensive air showers at distances from abo 40 m to about 400 m from the shower cores were studied at an alt tude of 4200 m (atmospheric depth 630 g/cm^{-2}) by 1 m^2 scintillati detectors in an array of 700 m diameter, and the arrival direction of each shower was determined by timing methods. It is reported that at this height the steepness of the lateral distribution decreases with zenith angle, and that showers of 3×10^7 particles show a behaviour consistent with those nearing their maximum longitudinal development. E.W.Kellerma

3369 TIME VARIATIONS OF EXTENSIVE AIR SHOWERS. A.Citron.
Ergeb. exakt. Naturwiss. (Germany), Vol. 32, 79-117 (1959).
In German.

Review article.

3370 PHASE CHANGES IN THE DAILY VARIATION OF THE COSMIC RAY NUCLEONIC COMPONENT. N.R.Parson
Tellus (Sweden), Vol. 12, No. 4, 450-62 (Nov., 1960).

Results of the analysis of solar daily variations in the cosmic-ray nucleonic component at nine stations during the I.G.Y. are presented. Examination of month to month phase behaviour leads t the conclusion that there is an important component variation synchronized in Universal Time at all stations, and its origin is discussed. Its effects on inferences about the primary anisotropy responsible for the main part of the daily variation and on various characteristics of the observed variation are also discussed.

3371 ASYMMETRY IN THE RECOVERY FROM A VERY DEEP FORBUSH-TYPE DECREASE IN COSMIC-RAY INTENSITY. D.C.Rose and S.M.Lapointe.
Canad. J. Phys., Vol. 39, No. 2, 239-51 (Feb., 1961).

The intensity-time curves for cosmic rays recorded at some 30 stations distributed all over the world are examined for structure in the recovery period from the third in a series of three closely spaced Forbush-type decreases which occurred in the middle of July, 1959. It is shown that the structure of intensity peaks is regular and that these occur at each station at the same effective local time. It is found that this is consistent with the hypothesis that recovery from a very deep Forbush-type decrease is first apparent directions making 15° and 165° with the sun—earth line respectively. The analyses suggest further, that during recovery from this deep Forbush decrease temporary openings appeared in the intensity depressing mechanism which allowed intensity increases in limited directions.

3372 THE SUDDEN SHORT-TERM INCREASE OF COSMIC RADIATION ON 4 MAY 1960 AS OBSERVED BY REGISTRATION OF THE NUCLEON COMPONENT AT THE JUNGFRAUJOCH. H.Debrunner, F.G.Houtermans and W.Lindt.
Helv. phys. Acta (Switzerland), Vol. 33, No. 6-7 706-8 (1960).
In German.

A cosmic-ray neutron detector of type B203 situated at the Jungfraujoch (3550 m above s.l., 47° 56' N, 7° 59' E) registered a sudden intensity increase of 9.3 ± 0.6% of the prevailing mean intensity. The increase began at 10.32 ± 2 min, reached its peak at 10.50 ± 2 min and fell of rapidly after 11.00 G.M.T. It is assumed to have been connected with the solar flare observed between 10.20 and 10.25 G.M.T. on that day and attention is drawn t special features of the event. E.G.Michaeli

3373 THE DAILY VARIATION OF THE COSMIC RAY NUCLEONIC COMPONENT AT MURCHISON BAY AND UPPSALA. A.E.Sandström, E.Dyring and S.Lindgren.
Tellus (Sweden), Vol. 12, No. 3, 332-4 (Aug., 1960).

In both places the monitors were of the standard pattern with 12 proportional counters filled with 97% enriched $B^{10}F_3$. The first and second harmonics of the mean daily variation were determined both for yearly periods and for each sun rotation period. Vector sum diagrams for the first harmonics in the latter case are given covering the intervals from 31 Aug. 1956 to 15 Aug. 1959 for Uppsala, and from 13 Sept. 1957 to 29 April 1959 for Murchison Bay In some instances a considerable phase shift took place from one sequence of sun rotation periods to another. These phase shifts were not contemporary at the two stations. The first harmonic of the 12-month means displays a high degree of constancy with only a small secular phase shift. The amplitudes of the second harmonics

are very small. Conditions are especially favourable concerning the deviation in the earth's magnetic field of the particles registered by the Murchison Bay monitor. Accordingly it has been possible to determine the direction of the anisotropy with a fairly good accuracy. The Murchison Bay records do not show any prominent phase shift with the K_p index. At Uppsala, days with $[K_p]_{max} \leq I$ have a later time of maximum than other days. The influence of single days with an abnormal daily variation is discussed.

3374 OBSERVATION OF RELATIVISTIC CHARGED PARTICLES IN A LUMINESCENCE CHAMBER.
B.A.Demidov and S.A.Fanchenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 64-6 (July, 1961). In Russian.

Photographs of cosmic-ray μ-mesons with a ionizing power near minimum were obtained in a luminescence chamber. The NaI:Tl crystal was 7 cm in diameter and 1 cm thick. A block diagram of the electronics set-up and three photographs are given. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 1, 46-51 (Jan., 1961)]. G.Martelli

3375 MOMENTUM SPECTRUM OF MUONS.
W.Pak, S.Ozaki, B.P.Roe and K.Greisen.
Phys. Rev. (USA), Vol. 121, No. 3, 905-7 (Feb. 1, 1961)

The momentum spectrum was measured with a magnetic spectrometer for cosmic-ray particles incident vertically and at 68^0 zenith angle, in the range 2 to 70 BeV/c. The apparatus discriminates strongly against all particles but muons. The vertical muon spectrum is found to be in good agreement with the results reported by Pine et al. and by Ashton et al. No comparable data at 68^0 have been published. Assuming muon creation to occur entirely through pion decay, a single pion production spectrum accounts for the muon spectra at both zenith angles. The muon positive excess at energies of 8 to 50 BeV was also obtained. The results, while in general agreement with those of other workers, confirm the expected tendency for the positive excess to decrease with energy.

NUCLEUS

3376 PERTURBATION THEORY IN FINITE NUCLEI.
J.da Providencia.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 81-92 (Jan., 1961).

In the surface region of a nucleus the nucleon density is lower than in the interior, and it might be expected that this will reduce the effect of the Pauli principle in suppressing correlations. Since in light nuclei the surface region is more important, one expects perturbation theory to work less well and correlations to be more important, than in uniform nuclear matter. Calculations with a simple model for O^{16} show that the second-order correction to the energy is almost exactly the same as for uniform nuclear matter, but that two-body correlations are indeed enhanced considerably.

539.14 : 539.17

NUCLEAR STRUCTURE FROM PROTON REACTIONS.
See Abstr. 3439

3377 MESON THEORETICAL POTENTIAL AND NUCLEAR PROPERTIES. T.Sasakawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 168-70 (Jan., 1960).

The potential in nuclear matter is evaluated in Born approximation from a two-body potential containing a hard core and the one-pion exchange tail. It is argued that most of the exchange term comes from the tail. The effective mass is estimated.
D.W.L.Sprung

3378 EXPERIMENTAL EVIDENCE FOR CLUSTER STRUCTURES IN LIGHT-AND MEDIUM-WEIGHT NUCLEI.
R.K.Sheline and K.Wildermuth.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 196-219 (Nov. (5), 1960).

The assumption of this paper in accordance with the cluster model is that nuclei may be considered to be composed of clusters (single nucleons, H^2, He^3, H^3, He^4, etc.). Comparison of cluster-model predictions and experimental level schemes are made for the nuclei Li^7, Be^7, C^{12}, O^{16}, F^{19}, Ne^{20}, Ca^{40} and Sc^{43}. It is shown that comparisons between the spectra of certain pairs of nuclei are particularly relevant from the viewpoint of the cluster model. Comparisons of the spectra of the following pairs of nuclei are made: N^{16}, O^{17}; F^{19}, Ne^{20}; K^{40}, Ca^{41}; and Sc^{43}, Ti^{44}. In addition the cluster model predicts levels of parity different than the ground state. The relative positions of these levels are compared in nuclei in which the smallest cluster is varied from a single nucleon to larger clusters. This model further predicts that immediately after double closed-shell structures, nuclei with H^3 or He^3 clusters (e.g., F^{19}) will exhibit a strong decrease in this excitation energy. The negative parity states and first 0+ states in alpha-particle nuclei should decrease with increasing atomic number. These predicted systematics agree with the limited experimental data which are available but suggest the need for considerable additional data to further test the predictions. These results indicate substructures which are often more important than shell-model structures.

3379 STABILITY CONDITIONS AND NUCLEAR ROTATIONS IN THE HARTREE–FOCK THEORY.
D.J.Thouless.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 225-32 (Nov.(5), 1960).

An expression for a general Slater determinant is written in the notation of second quantization. This expression has just the right number of arbitrary coefficients, so no subsidiary conditions are required, and the expression for a particular determinant is unique. This notation is used to study two problems. Firstly, a condition for a particular solution of the Hartree–Fock equations to minimize the expectation value of the Hamiltonian is derived. This condition is equivalent to the condition for stability of collective modes in the random phase approximation. Secondly, the determinant which minimizes the expectation value of the Hamiltonian while giving a particular value to the expectation value of a component of angular momentum is found. In this way, an expression for the moment of inertia of an axially symmetric system is derived within the framework of the Hartree–Fock theory. The expression for a determinant is generalized to include the type of wave-functions used in the theory of superconductivity.

3380 A MODEL FOR THE CALCULATION OF THE OPTICAL POTENTIAL IN SOME FINITE NUCLEI. B.Jancovici.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 256-69 (Nov. (5), 1960).

Describes an explicit calculation of the optical potential, up to the second order in perturbations, in a simple model for the finite nuclei He^4, O^{16}, Ca^{40}, which are pictured as made of nucleons bound in an harmonic oscillator average potential; finite nucleus wave-functions are used through the whole calculation, and no results pertinent to the infinite nuclear matter case are used. Numerical results for the imaginary potential are presented. Although the model is very crude, it is interesting to compare the results with those obtained through the Thomas–Fermi approximation, if only to test this approximation. It is found that the imaginary potential at low energy has a maximum in the surface, a conclusion which had been previously derived only in the frame of the Thomas–Fermi approximation.

3381 THE DIPOLE STATE IN NUCLEI.
G.E.Brown, L.Castillejo and J.A.Evans.
Nuclear Phys.(Internat.), Vol. 22, No. 1, 1-13 (Jan., 1961).

The mechanism of the particle–hole interaction in producing the "dipole state", i.e., the giant dipole resonance, in nuclei is discussed in detail. Calculations in j–j coupling are carried out with zero-range forces for the nuclei O^{16} and Ca^{40}. Comparison with finite-range calculations in the case of O^{16} shows that the zero-range calculations reproduce well not only qualitative, but also most quantitative features. In all cases, the particle–hole interaction concentrates the dipole-strength in the uppermost states, the energies of which are also shifted upwards by the interaction.

3382 LONG RANGE CORRELATIONS AND PHOTO EFFECT IN NUCLEI. W.Brenig.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 14-33 (Jan., 1961).

A detailed quantum mechanical treatment of the collective model for the giant dipole resonance in the low-energy nuclear photoeffect is presented. A relation $\omega_D = ck_D$ for the resonance energy ω_D is derived from sum-rule considerations, where k_D is related to the nuclear radius by $k_D \cong \pi/2R$ and c to the structure factor s(k) of nuclear matter at small momenta k by $s(k) = k/2mc$. The velocity c is calculated and the semiclassical expression for c in terms of the symmetry energy K [$c = (2K/m)^{1/2}$] is found to be valid only for extremely strong interactions. For weaker forces one obtains a larger value of c than indicated by this relation and a value of ω_D in better agreement with the results of shell-model configuration mixing calculations.

3383 LIQUID-DROP NUCLEAR MODEL WITH HIGH ANGULAR MOMENTUM. R.Beringer and W.J.Knox.
Phys. Rev. (USA), Vol. 121, No. 4, 1195-200 (Feb. 15, 1961).

The equilibrium shapes of rotating liquid drops are calculated in the spheroidal approximation. The solutions are prolate forms for high angular momenta such as are produced in compound nuclei resulting from heavy-ion bombardments. This is thought to account for the angular and energy distributions observed in heavy-ion-induced fission and light-particle evaporation.

3384 ON THE COLLECTIVE EXCITATION OF SPHERICAL NUCLEI. M.Kobayasi and T.Marumori.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 387-9 (Feb., 1960).

An approximation method developed in a previous paper (Abstr. 20314 of 1960) is applied to a model Hamiltonian containing a pairing and a quadrupole–quadrupole interaction to obtain the quadrupole vibrations of a spherical nucleus. J.Goldstone

3385 SPIN–ORBIT SPLITTING AND TENSOR FORCE. I. T.Terasawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 87-105 (Jan., 1960).

The effect of the tensor force on the spin–orbit splitting in He^5 and N^{15} is examined by using the meson-theoretical potential and the phenomenological Serber potential which are consistent with the experimental data on two-nucleon systems. About a half of the experimental values of the spin–orbit splitting in these nuclei are obtained by the accurate computation of the second-order effect in perturbation theory, whereas several previous calculations of this effect have yielded splitting of wrong sign or of too small a magnitude. The deformation of the closed shell core induced by the tensor interaction between the nucleons in the core is restricted so as to satisfy the Pauli principle with the outside nucleon. This restriction is mainly responsible for the present result of splitting energy.

3386 SPIN–ORBIT SPLITTING AND TENSOR FORCE. II. A.Arima and T.Terasawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 115-36 (Jan., 1960).

General formulae of the second-order perturbation energies due to the tensor force are given in the case of the "closed-shell+one" nuclei, and useful formulae for calculating the two-body matrix elements are also derived. Using these formulae, the D-state doublet splitting in O^{17} is estimated and it is found that about a half of the observed value is explained in terms of the second-order effect of the tensor force as in the case of He^5 and N^{15}.

3387 A RESONANCE EFFECT OF ACOUSTIC PULSES ON A NUCLEAR SPIN SYSTEM. A.R.Kessel'.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 872-7 (Sept., 1960).
In Russian.

The effect of acoustic pulses of a resonance frequency ω and $t_\omega < T_2$ on a system of nuclear spins $I > 1/2$ is examined theoretically. It is shown that in contrast to the action of an electromagnetic field on the spin system, a single acoustic pulse does not induce a free precession signal in the first approximation in $\hbar\omega/\kappa T$. Two acoustic pulses produce a spin-echo signal which equals that produced by electromagnetic pulses. [English translation in: Soviet Physics–JETP (USA)].

3388 THE SPIN OF ^{124}Sb AND THE SPIN AND MOMENTS OF ^{122}Sb. P.C.B.Fernando, G.K.Rochester and K.F.Smith.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 1309 (Dec., 1960).

Using the atomic beam magnetic resonance method, the spins of Sb^{124} and Sb^{122} were determined to be 3 and 2, respectively, in agreement with previous work. S.J.St-Lorant

3389 CONTRIBUTION TO THE THEORY OF THE MÖSSBAUER EFFECT. I.P.Dzyub and A.F.Lubchenko.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 1, 66-9 (Jan. 1, 1961).
In Russian.

Studies the criteria determining the shape of the intensity curve and the presence in the spectrum of unshifted lines, taking into account the dependence, upon the nuclear state, of the equilibrium positions and the normal frequencies of the lattice. The temperature shift of the Mossbauer line is determined. Maxima corresponding to emission and absorption are separated by a distance greater than the nuclear recoil energy from the Mossbauer line, the intensity of which is also decreased due to the effects of the displacements of the nuclei. [English translation in: Soviet Physics–Doklady (USA)]. E.A.Sanderson

3390 A SYSTEMATIC STUDY OF π^--MESIC DECAYING HYPERNUCLEI PRODUCED BY K^--MESONS. J.Tietge.
Nuclear Phys. (Internat), Vol. 20, No. 2, 227-53 (Oct. (4), 1960).
German.

A stack of nuclear emulsions (Ilford G5), exposed to the 300 MeV/c K^--beam of the Berkeley Bevatron, was scanned systematically for hypernuclei. 36 hypernuclei decaying by the π^--mesic mode were found. 24 of these hypernuclei could be analysed uniquely in the sense of the criteria given. Binding energies are obtained for $_\Lambda He^5$, $_\Lambda Li^8$ and $_\Lambda Li^9$. Angular, energy and momentum distributions of the $_\Lambda He^5$ decay products are studied and compared with the corresponding theoretical distributions given by Byers and Cottingham. The mean lifetime for $_\Lambda H^4$ hypernuclei is calculated. Finally, the nuclear capture of a Σ^--hyperon is described, from which a hydrogen nucleus (very probably a proton) and a π^--meson were emitted.

Energy Levels

3391 THE GROUND STATES OF NUCLEI. I. M.Ya.Amus'ya.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 639-50 (Sept., 196
In Russian.

A variational principle is formulated and applied to a many-particle system with two-particle interaction. The wave-function is chosen in a form which permits pair correlation to be allowed for exactly. Equations are obtained for one- and two-particle functions in the first approximation with respect to correlations. It is shown that they can easily be extended to the case of strong correlations and three-particle interactions. The results are applied to the case of nuclear matter. The equations obtained are compared with those of Brueckner. [English translation in: Soviet Physics–JETP (US

3392 RADIATION FROM A NUCLEUS IN THE PRESENCE OF UNEXCITED NUCLEI OF THE SAME TYPE. M.I.Podgoretskii and I.I.Roizen.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1473-5 (Nov., 19
In Russian.

The effect of such γ-radiation is shown in two examples. First the problem of the interaction of the two atoms of a diatomic molecule is considered and this is then generalized to the case of a linear chain of atoms, in order to give observable quantities. [English translation in: Soviet Physics–JETP (USA)]. A.M.Gre

3393 VIBRATIONAL STATES OF NUCLEI IN THE RANDOM PHASE APPROXIMATION. D.J.Thouless.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 78-95 (Jan., 1961).

The properties of those states which can be obtained by exciting a single particle from the ground state of a nucleus are studied by using a perturbation-theory expansion for the Green's function. The formula obtained differs from the one used in a straightforward shell model calculation in some important respects. By comparing this formula with the condition for a solution of the Hartree–Fock equations to give a minimum of the expectation value of the energy, derived in an earlier paper, it is shown that it is always possible to choose an independent particle wave-function which makes all collective modes stable in the random phase approximation. A study of the formal properties of solutions of the equation shows that the wave-functions should be normalized using an indefinite metric: different eigenfunctions are then orthogonal. The eigenfunctions form a complete set, if there is no degeneracy in the solution of the Hartree–Fock equations, but not if there is a degeneracy. An upper bound for the lowest energy level is established, and the rule for calculating matrix elements of one-particle operators between the ground state and an excited state is given. It is shown to follow from the self-consistent field condition that the energy-weighted sum rules are preserved in this approximation. A discussion of spurious states is given, and it is shown that they separate out and have zero energy. A vector introduced in an earlier discussion of the cranking model is shown to be independent of all eigenvectors in this case.

3394 SPURIOUS STATES ARISING FROM THE CENTRE-OF-MASS MOTION OF A NUCLEUS. E.Baranger and Chong Wan Lee.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 157-63 (Jan., 1961).

A simple method is given for generating the spurious states which arise from the incorrect treatment of the centre-of-mass motion

by nuclear shell-model calculations. It is not necessary to know the spurious states in order to find their weight in a particular shell model state. It is also shown which jj configurations have no spurious states. Some examples are given.

3395 STUDY OF NUCLEAR STRUCTURE FROM COULOMB ENERGY DIFFERENCES OF MIRROR LEVELS.
K.Wildermuth and Y.C.Tang.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 17-19 (Jan. 1, 1961).

Excitation energy differences of mirror levels in light nuclei are predicted from cluster structures. Agreement with experiment is fairly good. Alternatively, the empirical Coulomb energy behaviour can provide valuable information about the cluster structure of these levels. E.A.Sanderson

3396 ENERGY LEVELS OF Be^9 AND B^9.
R.R.Spencer, G.C.Phillips and T.E.Young.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 310-26 (Nov. (5), 1960).

The low-lying energy levels of Be^9 and B^9 were investigated by means of magnetic analysis of the $Be^9(p,p')Be^9$ and $B^{10}(He^3, \alpha)B^9$ reactions, respectively. Several distinctive features of the data result in a model being proposed to describe the low-lying energy level structure of these mirror nuclei. The model describes the mass-nine nuclei as two-body cluster states of $Be^8(0^+)$ + nucleon and gives quantitative agreement with the experimental width of the states. A generalized density-of-states function is employed to describe the continuum spectra, and allows a description of the cusp effects in the spectra of the two nuclei as aspects of two-body cluster spatial localization, and many-body decay occurring as a sequence of two-body separations.

3397 NUCLEAR STRUCTURE STUDIES IN THE LEAD REGION WITH (d,t) REACTIONS.
B.L.Cohen, S.Mayo and R.E.Price.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 360-9 (Nov. (2), 1960).

Energy distributions of tritons from (d,t) reactions in the isotopes of Pb, Bi and Tl were measured with ~ 100 keV resolution. Evidence is given on the location of the missing $h_{9/2}$ state in Pb^{207}. As theoretically expected, the spectrum from $Bi^{209}(d,t)$ is quantitatively similar to that from $Pb^{208}(d,t)$ except that all levels are split into two or more components. The energies of the states excited by $Pb^{207}(d,t)$ agree well with those predicted from the True and Ford calculation (Abstr. 9006 of 1958). The cross-sections for exciting these agree reasonably well with calculations using the True and Ford wave-functions, but several changes in the latter are suggested, including a reduction of the $(p_{1/2})^{-2}$ configuration in the ground state from 73% to about 55%. The long sought 0+ state apparently occurs at 1.19 MeV. The spectra from $Pb^{206}(d,t)$ and from $Tl^{205}(d,t)$ show marked similarities to each other and a general similarity with the spectrum from $Pb^{208}(d,t)$; it is shown that this is to be expected. In general, the shell model of nuclear structure with inverse stripping reaction theory gives a satisfactory quantitative explanation of all the data.

3398 NUCLEAR STRUCTURE STUDIES IN THE LEAD REGION WITH (d,p) REACTIONS.
B.L.Cohen, R.E.Price and S.Mayo.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 370-81 (Nov. (2), 1960).

Energy distributions of protons from (d,p) reactions in the isotopes of Pb and Bi were measured with ~ 100 keV resolution and angular distributions of several of the groups were studied. The angular distribution from $Pb^{207}(d,p)Pb^{208}$(g.s.) agrees very well with the distorted wave Born approximation calculation of Tobocman (Abstr. 12675 of 1959) and with measured angular distributions of $l_n = 1$ transitions in $Pb^{208}(d,p)Pb^{207}$. The difference from a measured $l_n = 3$ transition is quite large. From studies of the excitation of the various single hole states of Pb^{207} in $Pb^{208}(d,p)Pb^{207}$ the wave-function of the ground state of Pb^{208} is determined to be approximately

$$\Psi_{208} = \sqrt{0.56}(p_{1/2})^{-2} + \sqrt{0.25}(f_{5/2})^{-2} + \sqrt{0.12}(p_{3/2})^{-2} + \sqrt{0.04}(i_{13/2})^{-2} + \sqrt{0.03}(f_{7/2})^{-2},$$

which has less $(p_{1/2})^{-2}$, and more $(f_{5/2})^{-2}$, $(i_{13/2})^{-2}$ and $(f_{7/2})^{-2}$ than the theoretical wave-functions of True and Ford (Abstr. 9006 of 1958) and of Kearsley (Abstr. 3318 of 1958). A new low lying non-hole state of Pb^{207} is found Extensive efforts to understand the spectrum from $Pb^{208}(d,p)Pb^{209}$ are reported. The relative intensities of the various peaks are very difficult to explain.

3399 SURFACE DIFFUSIVENESS AND PHENOMENOLOGICAL TREATMENT OF O^{17} NUCLEUS. Y.Akiyama.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 903-14 (May, 1960).

The effects of surface diffusiveness on the single-particle level structure and wave-functions are investigated in a pure single particle model. It is shown that the ground state and the first excited state of O^{17}, which are interpreted as giving $1d_{5/2}$ and and $2s_{1/2}$ shell levels respectively, and low-energy elastic scattering of neutrons by O^{16} can be well reproduced by a diffuse potential well. In particular, it is pointed out that the relative location of $2s_{1/2}$ and $1d_{5/2}$ levels depends sensitively on finer details of the surface diffusiveness. The modifications of the single-particle wave-functions from pure harmonic oscillator functions are further investigated, and they are found to be small up to 1p states, but for higher states they may be so large that with pure oscillator functions one cannot hope to achieve quantitative agreement for nuclei near A = 16.

NUCLEAR DECAY RADIOACTIVITY

3400 RADIOACTIVE FALLOUT IN THE LENINGRAD REGION.
V.P.Shvedov, V.A.Blinov, L.I.Gedeonov and E.P.Ankudinov.
Atomnaya Energiya (USSR), Vol. 5, 577 (1958). In Russian. English translation in: Reactor Science (GB), Vol. 11, No. 1, 48-52 (Nov., 1959).

The fallout activity was measured in the Leningrad region in 1954-1957. It is shown that there was a considerable rise in 1957 with a subsequent sharp falloff. The rate of accumulation, however, showed no tendency to reach a state of equilibrium — rising from 13 mc/km² in 1954 to 151 mc/km² at the end of 1957.

C.F.Barnaby

Ag^{107} IN METEORITES: POSSIBLE FORMATION FROM AN EXTINCT Pd^{107} RADIONUCLIDE. See Abstr. 2608

3401 ON THE RADIOACTIVE PARTICLES IN THE ATMOSPHERIC FISSION PRODUCT ACTIVITY. W.Kern.
Nukleonik (Germany), Vol. 2, No. 5, 203-13 (Sept., 1960). In German.

A review article on the production and properties of "hot particles" (particles with an activity $\geq 10^{-10}$ Curie particle) found after nuclear explosions. Concludes with a brief discussion of meteorological and biological problems. J.M.Hough

3402 THE SIGNIFICANCE OF THE GENERALIZED DENSITY OF STATES FUNCTION FOR NUCLEAR SPECTRA.
G.C.Phillips, T.A.Griffy and L.C.Biedenharn.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 327-39 (Nov. (5), 1960).

The cluster model of the nucleus suggests that three- (or more-) body decay may be treated as a time sequence of two-body interactions. The cross-section for particle emission into a spectrum of energies may be calculated if it is assumed that the reaction $a + A \rightarrow D^* \rightarrow b + C + c$ occurs as a sequence of two-body decays: $D^* \rightarrow B^* + b$; $B^* \rightarrow c + C$. If B^* is produced in a localized state of radius a and decays only via the single two-body channel c + C whose phase shift is known, then the cross-section for emission of particles b is largely determined by a density-of-states factor $\rho = (1/\pi)d/dE_B[\delta_l(E_B) + \varphi_l(a, E_B)]$. This result is discussed and compared both with experiments and with other treatments of the same problem.

3403 A CONTRIBUTION TO THE THEORY OF UNSTABLE STATES. Ya.B.Zeldovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 776-80 (Sept., 1960). In Russian.

A perturbation theory is developed and for a given initial state, an expression is derived for the amplitude of a state which decays exponentially. An expression obtained which plays the role of the norm of such a state. [English translation in: Soviet Physics—JETP (USA)].

3404 DECAY OF 16 MINUTE Ta^{182m}.
A.W.Sunyar and P.Axel.
Phys. Rev. (USA), Vol. 121, No. 4, 1158-68 (Feb. 15, 1961).

A revised decay scheme of the 16 minute isomer Ta^{182m} involves three states of Ta^{182} at excitation energies of 147, 319 and 503 keV. Transition multipolarities were classified by measuring both gamma-ray coincidences and internal conversion electrons. The 503 keV isomeric state decays mainly (98%) by a 184 keV E3 transition to the 319 keV state. This 319 keV state decays mainly (94%) to the 147 keV state by means of a 172 keV transition that is predominantly M1. The 147 keV transition to the ground state is also predominantly M1. Two of the three possible crossover transitions were observed: a 356 keV M4 transition originates at the isomeric level and a 319 keV E2 transition connects the second excited state with the ground state. The 147 and 319 keV states are probably the first and second rotational states of the ground-state configuration. The relevant rotational parameters are of particular interest because very little is known about moments of inertia for odd–odd nuclei. The relative probabilities were determined for pile neutron activation of the 16 min isomer. Ta^{182m}, and the 112-day ground state, Ta^{182}. If the ground state formation cross-section is taken as 21 barns, the corresponding value for the isomer is only 9 mb.

3405 THE NEW ISOMERIC STATES OF SPHERICAL NUCLEI OF EUROPIUM WITH ODD MASS NUMBER.
E.E.Berlovich, V.N.Klemen'tev, L.B.Krasnov, M.K.Nikitin and I.Yursik.
Dokl. Akad. Nauk SSSR, Vol. 133, No. 4, 789-92 (Aug. 1, 1960). In Russian.

For abstract, see Abstr. 2181 of 1961. [English translation in: Soviet Physics–Doklady (USA), Vol. 5, No. 4, 816-19 (Jan.-Feb., 1961)].

3406 NEW APPLICATION OF DELAYED COINCIDENCE TECHNIQUES FOR MEASURING LIFETIMES OF EXCITED NUCLEAR STATES — Ca^{42} AND Sc^{47}.
P.C.Simms, N.Benczer-Koller and C.S.Wu.
Phys. Rev. (USA), Vol. 121, No. 4, 1169-74 (Feb. 15, 1961).

The new method is basically similar to the well-known prompt comparison method. Systematic errors can be reduced and greater accuracy obtained for nuclei which exhibit both a prompt and a delayed event. A transistorized time-to-amplitude converter was used. The mean life of the second excited state of Ca^{42} [$(4.8 \pm 0.3) \times 10^{-10}$ sec] and the first excited state of Sc^{47} ($< 5 \times 10^{-12}$ sec) were measured. The mean life of the first excited state of Hg^{198} [$(3.5 \pm 0.5) \times 10^{-11}$ sec] was determined by the usual self-comparison method.

3407 THE HALF-VALUE PERIOD OF RADIUM C'[Po^{214}].
K.W.Ogilvie.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 299-301 (Aug., 1960).

Describes measurements using the integral β-coincidence method. A value of 159.5 ± 3 μsec was found, tending to confirm the accurate Van Dardel value of 163.7 ± 0.1 μsec. Possible reasons for the lower values obtained by previous workers is discussed.
R.H.Thomas

3408 FORMULAS IN THE FERMI THEORY OF BETA DECAY. II. ON THE BETA RAY ANGULAR CORRELATION. Z.Matumoto.
Progr.,theor. Phys. (Japan), Vol. 23, No. 4, 531-61 (April, 1960).

For Pt I, see Abstr. 11349 of 1960. Previous work on the beta spectrum, which took into account the finite charge distribution of the nucleus and the screening effect, is extended to the beta-ray angular correlation, assuming the mixed interaction of vector and axial vector types (VA) and the nonconservation of parity in beta decay. These formulae for the allowed and the first-forbidden transitions have already been given by Morita and Morita for the case of the point nuclear charge (Abstr. 2550 of 1958). If the effective radii theory is used again, the final formulae can be expressed in forms similar to the familiar expressions for light nuclei in the usual formulations. The deviations of the coefficients from the usual ones are graphically shown as functions of beta-ray energies for Z = ±10, ±30, ±50, ±70 and Z = ±90 (for $\beta\mp$-decay), and significant deviations are found for heavy nuclei except for the allowed transition. These are especially significant for the non-unique first-forbidden, and the unique first- and second-forbidden transitions (several ten percents for Z ~ 90). One of the important results is that this theory is again insensitive to the nuclear charge distributions.

3409 THE PRESENT STATE OF THE THEORY OF BETA DECAY. Ya.Smorodinskii.
Uspekhi fiz. Nauk (USSR), Vol. 67(2), No. 1, 43-98 (Jan., 1959). In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 2(67), No. 1, 1-37 (Jan.-Feb., 1959).

This review gives a simple, systematic derivation of most of the formulae governing nuclear beta decay in allowed transitions, together with a summary of experimental results. The opening sections describe the formalism of the Dirac and Weyl equations and of parity, time-reversal and charge conjugation, giving physical interpretations wherever possible. There follow sections on: types of interaction, spectra and electron–neutrino correlation, electron polarization, polarized nuclei, $\beta-\gamma$ correlations, and the V–A interaction. There is a guide to the literature. The whole exposition is suitable for the non-specialist. J.C.Taylo

BETA DECAY AND THE WEAK INTERACTIONS.
See Abstr. 3132

3410 MEASUREMENTS ON β-DECAY AND ON NUCLEAR ISOMERISM BY MEANS OF THE SPLIT ANTHRACENE CRYSTAL SPECTROMETER. K.W.Hoffmann.
Nachr. Akad. Wiss. Göttingen II, math.-phys. Kl. (Germany), 1960, No. 13, 273-93. In German.

The author discusses applications of the instrument in problems of nuclear physics and β-spectrometry such as the investigation of continuous β-spectra (shape and maximum energy), decay schemes of Cu^{64}, Co^{60}, Dy^{165}, Dy^{165m}, Br^{80}, Br^{80m} and Hf^{179m}, half-lives, electron conversion line spectra of In^{114m} and Hf^{179m} for the determination of conversion coefficients, and measurements on positrons and α-particles. New measurements of the ratio K/(L + M + N) of conversion lines and of the half-life of Dy^{165m} yielded the results 0.112 ± 0.009 and 1.263 ± 0.016 min respectively, in agreement with earlier investigations. I.C.Demetsopoulos

3411 LONGITUDINAL POLARIZATION OF β-ELECTRONS FROM Au^{198}.
A.I.Alikhanov, G.P.Eliseev and V.A.Lyubimov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 587-8 (Sept., 1960). In Russian.

The ratio of the polarizations of electrons from Au^{198} and Tm^{17} (P_{Au}/P_{Tm}) is equal to 0.8 ± 0.05 at 145 keV and at 390 keV, 1.07 ± 0.08. [English translation in: Soviet Physics–JETP (USA)]. JETP (USA)].

3412 DISINTEGRATION OF ^{66}Ge.
R.A.Ricci, R.K.Girgis and R.van Lieshout.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 177-88 (Nov. (5), 1960).

The decay of Ge^{66} was investigated by scintillation techniques. The beta- and gamma-ray spectra were measured. Gamma–gamma coincidences were also studied. On the basis of these data a decay scheme is proposed and some features of the Ge^{66} disintegration are discussed.

3413 THE β-DECAY OF Nd^{147}.
H.D.Wendt and P.Kleinheinz.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 169-82 (Oct. (4), 1960). In German.

The β-decay of Nd^{147} was investigated using a double-lens spectrometer and fast-slow $\beta-\gamma$ coincidence technique, showing a total of five β-transitions, of which one has not been reported previously. Their end-point energies, partial intensities and log ft values are: 809 keV (64.7%), log ft = 7.6; 719 keV (10.4%), log ft = = 8.1; 480 keV (0.5%), log ft = 9.0; 370 keV (12.1%), log ft = 7.3, and 215 keV (12.3%), log ft = 6.5. A level scheme in agreement with the observed data is proposed and spins are discussed for the daughter nucleus Pm^{147}.

3414 LONGITUDINAL POLARIZATION OF β-ELECTRONS.
P.E.Spivak and L.A.Mikaelyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 574-83 (Sept., 1960). In Russian.

The longitudinal polarization of β-electrons from P^{32}, In^{114}, Sm^{153}, Lu^{177}, Ho^{166} and Au^{198} nuclei was measured at an energy of 300-340 MeV by Mott scattering (transformation of the longitudinal polarization into transverse). Differences up to 10% were detected in the degree of polarization of these nuclides. It was found that the absolute values of the polarizations lay in the range –(0.86-0.97) v. The error of the absolute measurements (± 3%) does not include possible inaccuracies of theoretical computation relating the polarization to the scattering asymmetry. [English translation in: Soviet Physics–JETP (USA)].

3415 LONGITUDINAL POLARIZATION OF O^{14} POSITRONS. J.C.Hopkins, J.B.Gerhart, F.H.Schmidt and J.E.Stroth.
Phys. Rev. (USA), Vol. 121, No. 4, 1185-9 (Feb. 15, 1961).

The longitudinal polarization of positrons from the pure Fermi transition of O^{14} was studied by the method of Bhabha scattering. A prismatic beta-ray spectrometer selected 1.0 MeV positrons which were than focussed by a solenoidal magnetic lens on a Supermendur foil magnetized by the lens. Scattered positrons and recoil electrons were detected in fast coincidence. The scattering asymmetry observed upon reversal of the lens magnetic field was (4.16 ± 0.80)%, which corresponds to positron longitudinal polarization +(0.97 ± 0.19) v/c.

3416 ELECTRIC MONOPOLE TRANSITIONS IN THE THEORY OF NON-AXIAL NUCLEI. V.S.Rostovskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 854-8 (Sept., 1960). In Russian.

It is demonstrated that, if the coupling between rotation and β-vibrations is taken into account, electric monopole transitions become possible between nuclear rotational states possessing the same moments and parities. The transition matrix elements between such states are calculated. The results are compared with experiments. [English translation in: Soviet Physics—JETP (USA)].

3417 MEASUREMENT OF THE β—γ CIRCULAR POLARIZATION CORRELATION IN ANTIMONY-124. G.Hartwig.
Z. Phys. (Germany), Vol. 161, No. 2, 221-37 (1961). In German.

The angular and energy dependence of the β—γ circular polarization correlation in the uniquely forbidden $3^- \text{-} 2^+$ beta transition were measured. The matrix element for this transition was determined uniquely and it was found that the principal contributions arise from the B_{ij} elements. The results could be explained on the basis of the selection rule effect. S.J.St-Lorant

3418 ANGULAR CORRELATION MEASUREMENTS IN Ba^{136}. Z.Grabowski, S.Gustafsson, I.Marklund and I.B.Häller.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 159-68 (Oct. (4), 1960).

The angular correlation of cascading transitions between levels in Ba^{136} excited from Cs^{136} were investigated with an automatic gamma—gamma directional correlation apparatus and with an electron—gamma correlation apparatus. The measured cascades are (keV): 1065—830, 1255—830, 337—1065 and 270—1065. They give give the following spins of energy levels in Ba^{136} (keV (I,π)): 0(0+), 830(2+), 1900(4+), 2090(4+), 2170(5+) and 2240(6+).

3419 TWO-CASCADE γ-TRANSITION IN THE Nd^{144} NUCLEUS ACCOMPANYING CAPTURE OF THERMAL NEUTRONS. V.R.Burmistrov and V.P.Radchenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 584-6 (Sept., 1960). In Russian.

The γ-radiation accompanying capture of thermal neutrons by the Nd^{143} nucleus was investigated by the sum-coincidence method with scntillation counters. Four two-cascade γ-transitions were determined. An energy level scheme, which includes the well-known 0.69 MeV level in the Nd^{144} nucleus, is proposed. The corresponding states are identified according to the relative cascade intensities. [English translation in: Soviet Physics—JETP (USA)].

3420 BETA—GAMMA DIRECTIONAL CORRELATIONS IN THE DECAY $Sb^{124} \rightarrow Te^{124}$. H.Paul.
Phys. Rev. (USA), Vol. 121, No. 4, 1175-9 (Feb. 15, 1961).

β—γ directional correlations involving the 1.6 MeV β-group of Sb^{124} and the second excited 2^+ state (at 1325 keV) of Te^{124} were measured. Both the γ-rays (0.72 and 1.32 MeV) de-exciting this state were used. For the 0.72 MeV γ-ray, the results for the coefficient ϵ in $W(\theta) = 1 + \epsilon P_2(\cos\theta)$ are: $\epsilon = 0.20 \pm 0.02$, 0.18 ± 0.02, 0.19 ± 0.03, and 0.22 ± 0.06 for β-energies of 1.02, 1.16, 1.30, and 1.44 ± 0.07 MeV, respectively. For the 1.32 MeV γ-ray, $\epsilon = -0.28 \pm 0.08$ for a β-energy range of 1.0-1.6 MeV. From these results, the mixing ratio for the 0.72 MeV γ-ray is $\delta = +0.8^{+0.7}_{-0.2}$. It is shown that the 1.6 MeV β-transition must be due, at least partly, to the B_{ij} matrix element. By assuming $u = x = 0$ (in Kotani's notation), these data can be fitted by either $Y/z = 0.04$ (i.e. an essentially unique transition), or $Y/z = 1.2$. Evidence for the existence of a 1.25 MeV level in Te^{124} is also given.

3421 DECOUPLING OF A TIME-DEPENDENT PERTURBATION CAUSED BY AFTEREFFECTS OF HOLE FORMATION. B.G.Pettersson, T.R.Gerholm, J.Thun and K.Siegbahn.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 14-16 (Jan. 1, 1961).

Time-dependent attenuation of the angular correlation pattern between successive radiations in electron capture or internal conversion decays might be expected for two reasons: (a) Interaction between the nuclear quadrupole moment Q and the crystal field gradients $\partial E/\partial z$. This effect was calculated by Abragam and Pound (Abstr. 2727 of 1954); (b) Magnetic coupling between the electron shell containing a hole, due to electron capture or internal conversion, and the nucleus. These effects were observed by investigating the 165 keV conversion electron — 134 keV γ cascade in Hg^{197m} using prompt and delayed coincidence techniques. Sources were produced by bombarding gold with 18 MeV protons and vacuum evaporating the Hg^{197m} activity on to either insulating or metallic backings. The time-dependent attenuations using the metallic backings were in good agreement with the quadrupole interaction calculations only, but when insulating backings were used an effect reducing the coefficient of $P_2(\cos\theta)$ by a further factor of 0.3 immediately after the K conversion was observed. This was attributed to an interaction of type (b). This was confirmed by decoupling the nuclear and orbital moments in a field of 3000 G, when the attenuation was found to be due to quadrupole coupling only. R.E.Meads

3422 HIGHER BORN APPROXIMATIONS IN PAIR CONVERSION. V.A.Krutov and V.G.Gorshkov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 591-9 (Sept., 1960). In Russian.

Considers higher Born approximations to the nuclear Coulomb field in pair-conversion transitions in nuclei. Exact first-approximation integrals yield a simple analytic result. [English translation in: Soviet Physics—JETP (USA)].

3423 POLARIZATION OF INTERNAL-CONVERSION ELECTRONS EMITTED AFTER β-DECAY OF ORIENTED NUCLEI. I.S.Baikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 624-32 (Sept., 1960). In Russian.

Considers correlation of the polarizations of conversion electrons and β-particles emitted in the decay of oriented nuclei. The calculation is carried out by taking into account the nuclear electric field. Formulae are derived for the angular distribution and the longitudinal and transverse polarizations of conversion electrons from any shell with an arbitrary multipole mixture. Numerical results for L_I, L_{II} and L_{III} shells refer to M1 and E2 multipoles or their mixture and are represented in the form of tables of the b^R_{kq} coefficients. These coefficients also determine the polarization of conversion electrons emitted after β-decay of non-oriented nuclei. The β-electron and conversion electron correlation can be employed to verify the invariance of β-interactions under time inversion. [English translation in: Soviet Physics—JETP (USA)].

3424 POLARIZATION OF INTERNAL-CONVERSION ELECTRONS AND POSITRONS EMITTED AFTER β-DECAY OF A NUCLEUS. G.A.Lobov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 684-8 (Sept., 1960). In Russian.

Considers the correlation between the direction of emission of internal-conversion electrons and positrons and the direction of emission of β-electrons during an earlier β-decay of a nucleus. The calculation is conducted for allowed β-transitions without taking into account the Coulomb field of the nucleus (in the Born approximation) under some very general assumptions regarding the β-interaction Hamiltonian. The expressions obtained refer to arbitrary $2j$-pole electric and magnetic types of nuclear conversion transitions. The case of VA-types of β-coupling (with time parity being conserved) is considered as well as the case of β-transitions involving a change by unity of the nuclear spin, $\Delta I = \pm 1$ ($\Delta T = \pm 1$). The polarization of internal-conversion electrons emitted after β-decay of the Na^{24} nucleus is calculated. [English translation in: Soviet Physics—JETP (USA)].

3425 INTERNAL CONVERSION ELECTRONS FROM COULOMB EXCITATION OF HEAVY ELEMENTS. D.H.Rester, M.S.Moore, F.E.Durham and C.M.Class.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 104-30 (Jan., 1961).

The spectra of internal conversion electrons due to Coulomb excited transitions in Au^{197}, the five abundant isotopes of osmium,

Th^{220}, and $U^{234, 236, 238}$ were obtained with a beta-ray spectrometer of the single-segment "orange" type. Some of the experimental problems connected with these measurements are discussed. Reduced transition probabilities were measured for the first 2+ excited states of all the even nuclei, none of which has been investigated hitherto by means of the conversion electrons. For the even isotopes of osmium, some evidence suggesting enhanced internal conversion is found. The quadrupole moments and deformation parameters derived from the reduced transition probabilities agree well with the values obtained in recent theoretical calculations. Evidence for a weak cascade transition between the well-known states at 548 and 279 keV in Au^{197} was found, and a level in Os^{189} at 69.7 keV is confirmed which is identified as the $\frac{5}{2}^-$ first excited rotational state. Two weak conversion lines in the osmium spectrum believed to be contributed by Os^{189} are assigned the probable transition energies of 194 and 256 keV.

3426 Dy^{155} AND Dy^{157} DECAY SCHEMES.
K.S.Toth and O.B.Nielsen.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 57-70 (Jan., 1961).

The disintegration schemes were studied. In addition to obtaining conversion-electron and γ-ray spectra, e–γ coincidence measurements were performed. The Dy^{157} results are conclusive and support the decay scheme proposed by Mihelich, Harmatz and Handley (Abstr. 597 of 1959) on the basis of differences and sums of accurately determined transition energies. The level in Tb^{157} at 327 keV is shown to be $\frac{5}{2}-$. The relative intensities of the three E1 γ-rays proceeding from this level to the three members of a ground rotational band based on a spin of $\frac{3}{2}+$ are found to agree with the corresponding branching ratios found for the analogous case in Tb^{159} involving a $\frac{5}{2}-$ 364 keV level and a ground rotational band again with a $\frac{3}{2}+$ base state. In both instances the experimental intensities disagree with the theoretical branching ratios. The Dy^{155} coincidence results are inconclusive due chiefly to the presence of interfering activities. However, these Dy^{155} data corroborate some features of a disintegration scheme proposed by Toth and Rasmussen (Abstr. 12639 of 1959) for this isotope and based on accurately measured transition energies. Also a new level in Tb^{155} at approximately 880 keV was established in the course of this investigation.

3427 SOFT γ-RAY SPECTRA EXCITED BY THERMAL-NEUTRON CAPTURE IN Cu^{63}, Cu^{65}, Ag^{107}, Ag^{109} AND In^{115}. V.V.Sklyarevskii, E.P.Stepanov and B.A.Obinyakov.
Atomnaya Energiya (USSR), Vol. 5, 454 (1958). In Russian.

Reports measurements of the low-energy γ-ray spectra excited by thermal-neutron capture in isotopically separated samples of Cu^{63}, Cu^{65}, Ag^{107}, Ag^{109} and In^{115}. Measurements were made up to about 300 keV using a NaI : Tl spectrometer. The results show a possible coincidence between the lower energy levels of Ag^{107} and Ag^{109}, with three lines of almost identical energy. The measurements on the copper and indium targets agree with previous data. [English translation in: Reactor Science (GB), Vol. 10, No. 3-4, 183-4 (Sept., 1959)]. R.H.Thomas

3428 RADIOACTIVE DECAY OF Tm^{167}.
H.Narasimhaiah and M.L.Pool.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 340-3 (Nov. (5), 1960).

Erbium oxide enriched in the mass number of 167 was irradiated with 12 MeV deuterons and 6 MeV protons. An activity with a half-life of 9.58 days was produced and ascribed to Tm^{167}. The spectrum consisted of Er K X-radiations and gamma-rays of 57, 208 and 532 keV and the observed relative intensities were 100, 5.4, 56.6 and 3.18 respectively. None of the gamma-rays was in coincidence with another. Transition probabilities and branching ratios are shown in a proposed energy level diagram.

NUCLEAR REACTIONS

(Including scattering by nuclei)

3429 ASYMMETRY EFFECTS AND VARIOUS MODELS OF HIGH-ENERGY NUCLEAR COLLISIONS.
S.Hayakawa, Z.Koba and S.Takagi.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 271-3.

The implications of applying quantum mechanical methods in the region of extremely high energies are discussed with particular reference to the following models: Fermi's statistical model; the hydrodynamical model; the isobar model; and the fire-ball model. . C.F.Barnab

3430 ONE-PARTICLE MOTIONS IN MANY-PARTICLE SYSTEMS AND THE OPTICAL MODEL IN NUCLEAR REACTIONS. M.Namiki.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 629-61 (April, 1960).

A possible scheme for the systematic one-particle motion in a many-particle system is presented from first principles as a time-dependent formalism. The theory is formulated and interpreted exclusively for the optical model of nuclear reactions, although the present formalism can be utilized to study various problems in solid-state physics. First the one-particle amplitude is defined so as to describe the processes of elastic scattering. Then it is shown that the systematic part of the amplitude, corresponding to the coarse-grained motion of the system, obeys the one-particle Schrödinger equation with the optical potential, and that the fluctuation part of the amplitude is governed by the Langevin-like equation with the same optical potential and the fluctuation–dissipation theorem. This is the same scheme assumed in a previous paper (Abstr. 20501 of 1960) from a semi-phenomenological point of view. The optical potential can be calculated from its definition as the Fourier transform of the so-called "self-energy" part appearing in the equation of the one-particle Green function in the medium of the target nucleus. From the definition it is easily seen that the optical potential is, in general, non-local and slightly energy-dependent. The optical potential is decomposed into two parts, one being the static (or energy-independent) part to be observed in the target nucleus in the fixed ground state and the other representing reaction of nuclear excitations. It is inferred that the former would not be so different from the corresponding term of the one-particle potential as expected in the ordinary shell model, and that the latter is small due to the average effect originating in the energy spread of the incident beam. The former is purely real, while the latter has an imaginary part which is responsible for the probability dissipation of elastic scattering. The face of the optical potential may be the same type irrespective of the question whether the incident beam is a simple short wave-packet or a mixed beam, so far as the coarse-grained motions are concerned. Finally, it is proved that the fluctuation–dissipation theorem holds for the correlation function of the fluctuating source or amplitude if the system is excited in quasi-equilibrium.

3431 DISPERSION FORMULAS IN THE THEORY OF NUCLEAR REACTIONS. V.I.Serdobolsky.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 245-55 (Nov. (5), 1960).

Gives a theory of resonances in nuclear reactions, in which the concept of the R-matrix is not used. Considers a certain parameter whose smallness makes it possible to select, out of the total number of formal levels obtained in the theory, the resonance levels attributable to the formation of a long-lived compound nucleus. For the levels which do not overlap the nuclear-reaction thresholds, the compound-nucleus resonances are singled out by the poles of the Green's function at complex energies. The dispersion formulae thus obtained are linear with respect to resonances and contain the complex reduced half-widths. These formulae do not depend on auxiliary "hypersurface radii" and take into account the tails of wave-functions responsible for multi-particle processes occurring close to the surface of the nucleus.

3432 A GENERAL RELATIVISTIC THEORY OF REACTIONS. M.I.Shirokov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 633-8 (Sept., 1960). In Russian.

The formulae of a general relativistic theory which express the cross-section and polarization in terms of phase shifts, may assume a different form depending on the definition of the relativistic spin operator. However the spin operators are identical in the rest system of a particle. This permits one to express the general theory in a form which is the same for all equivalent definitions of spin. [English translation in: Soviet Physics–JETP (USA)].

3433 THE INTERACTION RADIUS IN DIRECT REACTIONS. L.S.Rodberg.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 270-5 (Nov.(5), 1960).

In the direct interaction theory of nuclear reactions a parameter appears which describes the radius of the surface region in which the direct interaction takes place. Fits to experimental data using Born approximation theories lead to interaction radii which

are considerably larger than nuclear radii determined by other means. It is suggested here that this is a simple consequence of the distortion of the incident and outgoing waves, described in terms of an optical potential. This potential increases the relative momentum in the region of interaction, leading to smaller interaction radii for a given angular-momentum transfer. The energy independence of observed direct reaction angular distributions can also be understood in terms of the modified momentum inside the nuclear potential.

Due to Photons

3434 RESONANCE SCATTERING OF γ-RAYS ON THE Li^7 NUCLEUS. I.Sh.Vashakidze, T.I.Kopaleishvili, V.I.Mamasakhlisov and G.A.Chilashvili.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 666-8 (Sept., 1960). In Russian.

Correlation functions for resonance scattering of γ-rays involving excitation of the $\frac{5}{2}^-$ (7.46 MeV) level of the Li^7 nucleus are derived for the two cases of one-particle and rotational excitation. The lifetime of the $\frac{1}{2}^-$ state (0.477 MeV) of the nucleus is determined. [English translation in: Soviet Physics—JETP (USA)].

THEORY OF THE GIANT DIPOLE RESONANCE. See Abstr. 3381

3435 FINE STRUCTURE IN THE $^{12}C(\gamma,n)^{11}C$ ACTIVATION CURVE. I.M.Thorson and L.Katz.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 166-73 (Jan., 1961).

Fine structure in the $C^{12}(\gamma,n)C^{11}$ activation curve was examined in great detail. Eighteen breaks were found between threshold and 23 MeV. The positions of these breaks and the integrated cross-sections of the corresponding levels for the (γ,n) reaction are listed. Independent measurements in other laboratories indicate that resonance photon absorption into discrete levels may also be present for the (γ,p) reaction. The failure to observe structure in the (p,γ) inverse reaction thus remains unexplained.

3436 PHOTODISINTEGRATION OF Ne^{22}. A.P.Komar, Ya.Krzhemenek and I.P.Yavor.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 2, 291-3 (Nov. 11, 1960). In Russian.

A mixture of 89% Ne^{22}, 10% Ne^{20}, and 1% Ne^{21} was irradiated by bremsstrahlung of maximum energy 90 MeV in a cloud chamber. Relative yields of different processes are given, based on 1759 events; they are compared with yields for Ne^{20}. The (γ,pn) reaction occurs in 18% of events; it is suggested that the neutron is emitted second from an excited state of F^{21}. The (γ,α) reaction occurs in 8% of events compared with only 1% in Ne^{20}, while for $(\gamma,\alpha p)$ the figures are 1.5% and 22% respectively. [English translation in: Soviet Physics—Doklady (USA)]. D.W.L.Sprung

Due to Nucleons

3437 THE NEW VIEWPOINT OF THE HIGH ENERGY ELASTIC SCATTERING OF NUCLEONS FROM NUCLEI. T.Sasakawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 177-80 (Jan., 1960).

It is claimed that the main multiple-scattering effects may be represented as causing the direct two-body interaction to be reduced by a factor λ, for which an explicit form is given in terms of the free space two-body potential and a nuclear wave-function embodying the excitation of at least two particles from the Fermi sea. The struck nucleon is assumed to move in an average single-particle potential. The form of λ suggests that it should be independent of mass-number A for large A, and calculation confirms this in four typical cases; the calculated λ's tend to bring the impulse approximation calculations into better agreement with experiment. I.J.R.Aitchison

3438 ANALYSIS OF NUCLEAR INTERACTIONS OF $E \geq 10^{11}$ eV NUCLEONS IN PHOTOGRAPHIC EMULSIONS. E.G.Boos.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 616-23 (Sept., 1960). In Russian.

Experimental data on collisions between nucleons and photographic emulsion nuclei are compared with theories of multiple production of mesons in which the "tube" model is used. [English translation in: Soviet Physics—JETP (USA)].

INTERACTION OF HIGH-ENERGY NUCLEONS WITH COMPLEX NUCLEI. See Abstr. 3259

Due to Protons

3439 QUASI-FREE DIFFRACTION SCATTERING. G.Jacob and T.A.J.Maris.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 440-54 (Nov. (2), 1960).

Deals with processes of the type

$$N_A^Z(p, 2p)N_{A-1}^{Z-1},$$

in which, loosely speaking, an incoming proton of intermediate energy (50-500 MeV) knocks another proton out of a nucleus without any additional violent interaction of the incoming or the two emerging protons with the nucleus taking place. It is shown that a certain type of non-coplanar quasi-free proton—proton scattering on heavy and medium nuclei is able to give direct and clear information on the structure of the target nucleus and the mechanism of the interaction. It is expected that the parties and orbital angular momenta of the occupied single-particle states in the least bound shell, and for some cases in the stronger bound shells, can be determined. In addition the radial extension of the surface interaction zone and its distance from the centre of the nucleus would follow immediately from the expected interference patterns.

3440 ELASTIC SCATTERING OF POLARIZED 10 MeV PROTONS BY COMPLEX NUCLEI. L.Rosen, J.E.Brolley, Jr and L.Stewart.
Phys. Rev. (USA), Vol. 121, No. 5, 1423-37 (March 1, 1961).

The angular dependence of the polarization in the elastic scattering of 10 MeV protons by complex nuclei was investigated systematically. Strong polarization effects, which vary smoothly with scattering angle and atomic number of the target nucleus, appear to be a general feature of the scattering process. All the data are fitted reasonably well by a 5-parameter "optical model potential" (containing a spin-orbit term) in which the only variable is the $A^{1/3}$ dependence of the radius. The strength of the spin-orbit term required to account for the polarization is approximately the same as has been postulated in the shell model.

3441 COLLISIONS OF 9 GeV PROTONS WITH NUCLEI. V.S.Barashenkov, Van Shu-Fen and K.D.Tolstov.
Atomnaya Energiya (USSR), Vol. 5, 453 (1958). In Russian.

The characteristics of p—p and p—n collisions in nuclear emulsions irradiated with 9 GeV protons were investigated. [English translation in: Reactor Science (GB), Vol. 10, No. 3-4, 182-3 (Sept., 1959)]. C.J.Batty

3442 ON THE HIGH ENERGY PROTONS INELASTICALLY SCATTERED FROM C^{12} AND O^{16}. Y.Sakamoto.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 183-6 (Jan., 1960).

The differential cross-section is calculated using an impulse approximation, treating the interaction between the incident proton and the nucleons in the nucleus by a t-matrix, assuming that the giant resonances are related to the excitation modes of photonuclear reactions. The cross-section is given in terms of the two-body amplitudes, the ratio of spin-flip to non-spin-flip reduced matrix elements, and the cross-section for excitation of the nucleus by energy E_{exc} through the absorption of an E1 γ-ray. Fair agreement with experiment is claimed. I.J.R.Aitchison

3443 POLARIZATION OF PROTON SCATTERED FROM Li^6, Be^9, AND B^{11}. Y.Sakamoto and T.Takemiya.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 172-5 (Jan., 1960).

Expressions are given in terms of the Wolfenstein amplitudes for p—p and n—p scattering. It is assumed that the nucleons are in their shell-model ground states, and the expressions are equivalent to the impulse approximation. Similar formulae for inelastic scattering, for transitions to specific levels, are given. D.W.L.Sprung

3444 THE ELASTIC SCATTERING OF 160 MeV PROTONS FROM LITHIUM, ALUMINIUM, INDIUM AND GOLD. A.Johansson, G.Tibell, K.Parker and P.E.Hodgson.
Nuclear Phys. (Internat.), Vol. 21, No. 3, 383-92 (Dec. (1), 1960).

The differential cross-sections and asymmetries of protons

scattered elastically from lithium, aluminium, indium and gold were measured in the angular range 3-30°. The results are compared with calculations using the optical model, and overall agreement is found.

3445 19.6 MeV DIFFERENTIAL PROTON ELASTIC SCATTERING CROSS-SECTIONS FOR SOME SEPARATED ISOTOPES. R.A.Vanetsian, A.P.Klucharev and E.D.Fedchenko.
Atomnaya Energiya (USSR), Vol. 2, 123 (1957). In Russian. [English translation in: Reactor Science (GB), Vol. 12, No. 4, 210-15 (Aug., 1960)].

The differential elastic scattering cross-sections for 19.6 MeV protons on separated isotopes of Li, Co, Cu, Ge, Cd, Sn, Pb, Bi and U were measured. Considerable variations were found in the scattering by isotopes of the same element. C.J.Batty

3446 PICK-UP REACTIONS ON A ^{9}Be TARGET. F.H.Read and J.M.Calvert.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 65-76 (Jan., 1961).

Absolute differential cross-sections were measured for the $Be^{9}(p,d)Be^{8}(0)$ and $Be^{9}(p,p)Be^{9}(0)$ reactions at incident proton energies of 4.85 and 5.49 MeV, and for the $Be^{9}(d,t)Be^{8}$ reaction at 5.86 MeV; the pick-up reactions were analysed in terms of the Butler theory. A comparison of the (p, d) results with those at higher proton energies gives the ranges of validity of the Butler theory and the "transparent-nucleus" Born approximation pick-up theory for the reaction; the neutron reduced width is also deduced from these results. A comparison of the (d, t) results with those at higher deuteron energies shows consistency over a wide energy range: a comparison with the (p, d) reaction gives the triton form-factor $|A_J|^2 N_i^2$. Excitation functions were measured for the reaction products of Be^{9} + p for bombarding energies between 3.5 MeV and 6.0 MeV and for the reaction products of Be^{9} + d for bombarding energies between 3.8 and 6.3 MeV.

3447 10 MeV PROTON REACTION CROSS-SECTIONS FOR Cu^{63} AND Cu^{65}. R.D.Albert and L.F.Hansen.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 13-14 (Jan. 1, 1961).

The (p,n) cross-sections were measured using variable-energy protons from the Livermore 90 in. cyclotron and "long counter" neutron detectors. The results were 510 and 700 mbarns respectively, with an estimated error of 7%. These values differ appreciably from the weighted sums used by Meyer and Hintz (Abstr. 20432 of 1960), on which, together with their measurements of the (p,p') and (p,α) cross-sections, they base their assertions that the reaction cross-sections σ_R of Cu^{63} and Cu^{65} differ appreciably, and are significantly larger than the results of optical model calculations. The present results, combined with the measurements of Meyer and Hintz, yield σ_R = 857 and 855 mbarns for Cu^{63} and Cu^{65}. The results agree fairly well with a surface-absorption optical-model calculation of Bjorklund and Fernbach (Abstr. 8978 of 1958) using parameters chosen to fit proton elastic scattering and polarization data. R.E.Meads

3448 INVESTIGATIONS OF THE NON-RESONANT PART OF THE $Li^{7}(p,\gamma)$ RADIATION.
G.Breuer, V.Riech, E.Thormann and H.Neuert.
Z. Phys. (Germany), Vol. 161, No. 5, 500-8 (1961). In German.

The angular distributions of the 17.6 MeV γ-rays from the reaction $Li^{7}(p,\gamma)Be^{8}$ were measured between 0.4 and 0.65 MeV. The known strong asymmetry resulting from interference of the 441 keV resonance radiation and the non-resonance radiation, and a $\cos^2\Theta$-term, slowly increasing with energy, were observed. According to the results, the non-resonance radiation is predominantly due to s-wave capture, but in addition to this a small contribution of p-waves must be considered.

Due to Neutrons

3449 MEASUREMENT AND INTERPRETATION OF NEUTRON TOTAL CROSS-SECTIONS OF CARBON, CALCIUM AND LEAD. R.M.Wilenzick, G.E.Mitchell, K.K.Seth and H.W.Lewis.
Phys. Rev. (USA), Vol. 121, No. 4, 1150-8 (Feb. 15, 1961).

The neutron total cross-sections were determined in the energy region 200-960 keV using a time-of-flight technique. The observed cross-section for carbon was analysed in terms of the effective-range theory as well as the bound-level contribution, with results which agree very well with those obtained by the (d,p) stripping experiments. Also it is concluded that the upper limit for the total width of the "proposed" resonance in C^{13} at 610 keV is 100 eV. Fo calcium and lead the data are analysed for resonance parameters. It is found that the s-wave strength function for Ca^{40} increases rapidly with increasing energy. It is concluded also that the cours of the Pb cross-sections can be explained only by the presence of broad s-wave resonance in Pb^{208}, at E_n = 515 ± 15 keV with a neutron width Γ_n = 100 ± 15 keV.

3450 NEUTRON CROSS SECTIONS IN CHLORINE. G.S.Mani, T.A.Tombrello and D.A.A.S.N.Rao.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 344-6 (Nov. (5), 1960).

An upper limit of 5 mb was obtained for the $Cl^{37}(n,p)S^{37}$ react cross-section at a neutron energy of 17.5 MeV. The cross-sectio for the $Cl^{35}(n,2n)Cl^{34m}$ reaction was measured for neutron energie between 17 MeV and 22 MeV.

3451 NEUTRON CAPTURE BY F^{19}, P^{31} AND S^{32} NUCLEI. G.E.Velyukhov, A.N.Prokof'ev and S.V.Starodubtsev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 563-5 (Sept., 196 In Russian.

A telescope consisting of two proportional counters and a scin tillation counter was employed to study the energy and angular dis tributions of deuterons from the reactions F^{19} (n, d)O^{18}, P^{31}(n, d)S S^{32}(n, d)P^{31} and Ne^{20}(n, d)F^{19}. The cross-sections and angular dis tributions for transitions to the ground states of the O^{18}, Si^{30} and P^{31} nuclei are derived. The total cross-section for the reaction Ne^{20}(n, d)F^{19} is estimated. The reduced transition widths are com puted using Butler's theory. [English translation in: Soviet Physi JETP (USA)].

3452 (n,2n) EXCITATION FUNCTIONS OF SEVERAL NUCLEI FROM 12.0 TO 19.8 MeV.
R.J.Prestwood and B.P.Bayhurst.
Phys. Rev. (USA), Vol. 121, No. 5, 1438-41 (March 1, 1961).

(n,2n) excitation functions were obtained for Sc^{45}, Ti^{46}, Ni^{58}, Cu^{65}, Ge^{70}, As^{75}, Rb^{85}, Rb^{87}, Sr^{84}, Y^{89}, Zr^{90}, Nb^{93}, Ag^{107}, In^{115}, Sn^{112}, Sb^{121}, Sb^{123}, Ta^{181}, Au^{197}, Tl^{203}, and Th^{232} at incident neutron energies of 12.00 to 19.76 MeV. The target elements were expose to neutrons from the T(d,n)He^{4} reaction in Zr-T and T_2 gas target and the products were measured by radiochemical methods.

3453 THERMAL NEUTRON CROSS-SECTIONS FOR PRODUCING ISOMERS. II.
H.S.Hans, M.L.Sehgal and P.S.Gill.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 183-7 (Oct.(4), 1960).

For Pt I, see Abstr. 11477 of 1959. Thermal neutron cross-sections for the production of isomers were measured for the following cases, by making irradiations with the swimming-pool reactor at Trombay, Bombay: $Se^{78}(n,\gamma)Se^{79m}$, $Sr^{84}(n,\gamma)Sr^{85m}$, $Sr^{84}(n,\gamma)Sr^{85}$, $Rb^{85}(n,\gamma)Rb^{86m}$, $Ba^{132}(n,\gamma)Ba^{133m}$, $Ba^{134}(n,\gamma)Ba^{135m}$, $Ba^{136}(n,\gamma)Ba^{137m}$, $Os^{190}(n,\gamma)Os^{191,191m}$ and some others. An activation method was employed using scintillation technique. Isomeric ratios seem to follow the rule of Mateosian and Goldhabe (Abstr. 8344 of 1958).

3454 THE $U^{238}(n,2n)U^{237}$ CROSS-SECTION AT 15 MeV. G.P.Antropov, Iu.A.Zisin, A.A.Kovrizhnikh and A.A.Lb
Atomnaya Energiya (USSR), Vol. 5, 456 (1958). In Russian.

The measured cross-section for the reaction $U^{238}(n,2n)U^{237}$ was in agreement with the results of other workers and the value predicted by the statistical theory. [English translation in: Reactc Science (GB), Vol. 10, No. 3-4, 184-5 (Sept., 1959)]. C.J.Ba

Due to Mesons and Hyperons

INELASTIC SCATTERING OF A Σ^- HYPERON WITH AN EMULSION NUCLEUS. See Abstr. 3244

ASYMMETRY OF NEUTRONS FROM A μ-MESON REACTION IN LEAD. See Abstr. 3304

Due to Deuterons

3455 ELASTIC AND INELASTIC SCATTERING OF DEUTER ONS ON C, Mg, Ti, Fe, Ni, Cu AND Zn AT 11.8 MeV.
R.Jahr, K.D.Müller, W.Oswald and U.Schmidt-Rohr.
Z. Phys. (Germany), Vol. 161, No. 5, 509-24 (1961). In German.

The deuteron spectra were measured in steps of 5° between Θ_{lab} = 20° and 165°. The excitation of the lowest levels is in most nuclei strongly preferred and only very few low energy deuterons

were observed. The angular distributions of the elastic and inelastic scattering of deuterons show pronounced diffraction maxima which are partly correlated. The correlation is compared with the Blair model (Abstr. 432 of 1960).

DEUTERON POLARIZATION PRODUCED BY d–α SCATTERING AT 1.07 MeV. See Abstr. 3248

3456 LOW-ENERGY PROTONS PRODUCED IN THE DEUTERON BOMBARDMENT OF NUCLEI.
E.W.Hamburger, B.L.Cohen and R.E.Price.
Phys. Rev. (USA), Vol. 121, No. 4, 1143-9 (Feb. 15, 1961).

When nuclei are bombarded by fast deuterons a continuous spectrum of protons is observed at energies corresponding to $Q < -2.2$ MeV. The shape and angular distribution of this continuum were studied for several targets, from Li to Au, with 14.8 MeV deuterons. The angular distributions are strongly peaked at or close to 0^0 for light elements; for heavy elements the peak broadens and moves to $\sim 50^0$. The energy spectra shows a peak which, with increasing angle moves to lower energies for light elements, and moves to higher energies for heavy elements. All features of the results are explained using a semiclassical theory in which the deuteron is broken up in the external field of the nucleus. The breakup occurs at or near the nuclear surface for light elements, but quite far out from it in heavy elements. Observed cross-sections are far larger than theoretical predictions for either Coulomb or nuclear breakup.

3457 INTERACTION OF DEUTERONS WITH NUCLEI.
A.G.Sitenko.
Uspekhi. fiz. Nauk (USSR), Vol. 67, No. 2, 377-444 (Feb., 1959).
In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 2(67), No. 2, 195-235 (March-April, 1959).

A review article dealing with the theory of elastic and inelastic interactions of deuterons with nuclei in both the low- and high-energy region. C.J.Batty

3458 THE SPECTRUM OF α-PARTICLES FROM THE REACTION B^{10} (d,α) Be^8 AND THE EXCITED LEVELS OF Be^8 BETWEEN 0 AND 8 MeV.
R.Bilwes, C.Gérardin and D.Magnac-Valette.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2157-9 (Nov. 14, 1960).
In French.

A study of the energy spectrum of α-particles from the reaction B^{10} (d,α) Be^8 using a magnetic spectrograph in conjunction with photographic plates. No levels between 0 and 8 MeV in Be^8 were found, other than the already known level at 2.9 MeV.
R.H.Thomas

3459 ANGULAR DISTRIBUTIONS FOR C^{13}(d, n)N^{14}.
R.Zdanis, G.E.Owen and L.Madansky.
Phys. Rev. (USA), Vol. 121, No. 3, 854-7 (Feb. 1, 1961).

Angular distributions of neutrons corresponding to transitions to the first (2.31 MeV) and second (3.95 MeV) excited states in the reaction C^{13}(d, n)N^{14} were measured at an incident deuteron energy of 1.3 MeV. A time-of-flight technique utilizing the associated gamma ray as a trigger was employed to separate the various neutron groups. Because the data, particularly for the first excited state transition, exhibited a relatively large intensity in the backward direction, a simple deuteron-stripping process is not sufficient to account for the results. An analysis which included the heavy-particle stripping mode was consistent with the data.

DEUTERON REACTIONS IN THE Pb REGION. See Abstr. See Abstr. 3397

Due to Alpha-particles

3460 A STUDY OF THE ANGULAR DISTRIBUTIONS OF NEUTRONS LEADING TO THE GROUND STATE IN THE REACTION $^{12}C(^3He, n)^{14}O$.
N.H.Gale, J.B.Garg, N.M.Calvert and K.Ramavataram.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 313-20 (Oct. (4), 1960).

A pulsed beam time-of-flight neutron spectrometer was used to study the neutrons emitted from a target of C^{12} bombarded with singly ionized He^3 particles having energies of 4.09, 4.62, 5.16 and 5.70 MeV. The angular distributions of the neutron group leading to the ground state of O^{14} were compared with a double stripping theory, and good agreement was obtained with the theoretical prediction for transfer of zero orbital angular momentum. It is emphasized that the angular distributions alone are insufficient to distinguish between a stripping process or a direct knock-out mechanism, but arguments are advanced which favour the former. On the assumption that the mechanism of the reaction is that of double-stripping, the results lead to the assignment of a spin zero and even parity to the O^{14} ground state.

Due to other Particles and Nuclei

3461 INVESTIGATION OF SECONDARY CAPTURE OF LITHIUM NUCLEI BY LEAD.
Van Yun-yui [Wang Yung-Yü], V.V.Kuznetsov, M.Ya.Kuznetsova, V.N.Mekhedov and V.A.Khalkin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 527-35 (Sept., 1960).
In Russian.

Formation of astatine isotopes ($At^{211, 210, 207}$) in lead under bombardment with 80-660 MeV protons, 75-370 MeV deuterons and 210-810 MeV α-particles was studied by a radiochemical method. The astatine isotopes were obtained as a result of secondary capture of high-energy lithium nuclei produced in fragmentation. The At^{211} yield under α-particle bombardment reached 0.3 microbarn and was practically independent of the α-particle energy. Under proton and deuteron bombardment it increased with the particle energy, especially when the proton energy exceeded 400 MeV, and attained a value of 0.2 microbarn at an energy of 660 MeV. The At^{211} yield was independent of the lead target thickness for thicknesses ranging from 0.3 to 1.66 mm and decreased for thicknesses smaller than 0.3 mm. The production cross-section was computed and the energy spectrum of the captured lithium fragments was estimated on the basis of the astatine yield from lead. The cross-section for production of the high-energy fragments by 660 MeV protons was 3-6 millibarns. [English translation in: Soviet Physics–JETP (USA)].

3462 LITHIUM-INDUCED REACTION YIELDS BELOW 4 MeV.
E.Norbeck.
Phys. Rev. (USA), Vol. 121, No. 3, 824-7 (Feb. 1, 1960).

Thick-target yields of the following reactions were measured by counting the beta-active products: $Li^7(Li^6,2n)C^{11}$, $Be^9(Li^6,2n)N^{13}$, $C^{12}(Li^6,n)F^{17}$, $C^{12}(Li^7,n)F^{18}$, $N^{14}(Li^6,He^5)C^{15}$, $N^{14}(Li^6,d)F^{18}$, $N^{14}(Li^7,t)F^{18}$, $O^{16}(Li^6,n)Na^{21}$, $O^{16}(Li^6,He^4)F^{18}$, $F^{19}(Li^6,Li^5)F^{20}$, $Na^{23}(Li^6,Li^5)Na^{24}$. The reactions $F^{19}(Li^6,2p)Ne^{23}$ and $Na^{23}(Li^7,Li^6)Na^{24}$ had too small a yield to permit accurate measurement. All of the yield curves show a very rapid but smooth increase of yield with energy. Some general rules are given for estimating the yield to be expected for any positive "Q" lithium-beam reaction in the energy range under consideration.

3463 CLUSTER MODEL INTERPRETATION OF THE ISOTOPIC SPIN SELECTION RULE IN CERTAIN NUCLEAR REACTIONS. G.C.Morrison.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 565-7 (Dec. 15, 1960).

The reactions $Li^6(Li^6,d)B^{10}$ and $Li^6(Li^7,t)B^{10}$ were observed and their reference to the reactions leading to the T = 1, second excited state of B^{10} is considered. In both cases emitted particles leading to the T = 1 level in B^{10} are very much inhibited. A cluster model argument is given showing that there is no way for the Li^6 nucleus ($J = 1^+$) to capture an alpha particle ($J = 0^+$) through stripping to form a 0^+ (T = 1) state of B^{10}. Thus the introduction of the formal concept of isotopic spin conservation to describe the above inhibitions can be avoided. The same argument applies to the (Li^6,α), (α,d) and (d,α) reactions at energies where stripping involving the transfer of a deuteron is expected to be important.
F.Herbut

3464 NEUTRON TRANSFER TO EXCITED STATES IN N^{15} IN THE REACTION $N^{14}(N^{14},N^{13})N^{15}$. K.S.Toth.
Phys. Rev. (USA), Vol. 121, No. 4, 1190-2 (Feb. 15, 1961).

The neutron-transfer reaction, $N^{14}(N^{14},N^{13})N^{15}$, was investigated from 6^0 to 60^0 c.m. with 28 MeV N^{14} ions accelerated in the Oak Ridge 63 in. cyclotron. Circular strips of aluminium foil, each encompassing a known angular increment, were used to stop the radioactive N^{13} (10 min). Excited states in N^{13} are unstable with respect to proton emission; the first excited state in N^{15} is 5.28 MeV above ground. Therefore, N^{13} nuclei resulting from transfers to the ground state of N^{15} are at least 5 MeV more energetic than those resulting from transfers to N^{15} excited states. The two groups of N^{13} particles were distinguished by placing suitable absorbers in front of the aluminium catcher foils. It was found that transfers to excited states become more abundant relative to ground-state transfers as the incident N^{14} energy is lowered.

3465 EXCITED STATES OF O^{18} STUDIED BY THE REACTION $H^3(O^{16}_{4+},p\gamma)O^{18}$.
A.E.Litherland, R.Batchelor, A.J.Ferguson and H.E.Gove.
Canad. J. Phys., Vol. 39, No. 2, 276-94 (Feb., 1961).

Gamma rays from the excited states of O^{18} at 3.63 and 3.92 MeV were observed using the reaction $H^3(O^{16}_{4+},p\gamma)O^{18}$ at an incident O^{16} energy of 14 MeV. Both states were observed to emit gamma rays to the 1.98 MeV 2+ first excited state of O^{18}. No evidence for cross-over transitions was found and in each case the crossover transition was estimated to be ≤ 15% of the cascade transition. Angular correlations of the gamma rays were obtained and these strongly support an assignment of spin 0 to 3.63 MeV state and a spin of 2 for the 3.92 MeV state. These assignments have been confirmed by a recent experiment on the $O^{16}(H^3,p)O^{18}$ reaction which gives the assignments 0+ and 2+ for these two states. Thus the states at 3.55, 3.63, and 3.92 MeV form a triplet with assignments 4+, 0+, and 2+ which strongly resembles the vibrational spectra found in heavier nuclei. However, the measured angular correlations of the gamma rays from the 3.92 MeV state show only a small admixture of electric quadrupole in the 1.94 MeV gamma ray with relative amplitude $+0.1 \pm 0.1$. A lower limit of $\sim 10^{-12}$ sec on the lifetime of the 3.63 MeV state was obtained from the absence of a doppler shift of the 1.65 MeV cascade gamma ray.

LIQUID-DROP MODEL FOR HEAVY-ION-INDUCED REACTIONS. See Abstr. 3383

INTERACTION OF NEUTRINOS WITH COMPLEX NUCLEI, ASSUMING THE EXISTENCE OF A NEUTRAL LEPTON CURRENT. See Abstr. 3161

Nuclear Fission

3466 RESULTS IN THE PHYSICS OF NUCLEAR FISSION.
A.Kraut.
Nukleonik (Germany), Vol. 2, No. 4, 149-74 (June, 1960). In German.

A comprehensive survey of work on nuclear fission and properties of fission products. Over 400 references.

C.G.Morgan

3467 THEORY OF NUCLEAR FISSION.
W.Brunner and H.Paul.
Z.Naturforsch. (Germany), Vol. 15a, No. 11, 1018-19 (Nov., 1960). In German.

A nuclear interaction of the form

$$V_k = -V_k^0 \exp[-\mu(s-R)]$$

is introduced between the two fragments in the fission of U^{235}, where μ is the π-meson Compton wavelength, s is the separation and $R = 14 \times 10^{-13}$ cm. The values of V_k^0 are obtained by comparing with the experimental probabilities of different fragments, and exhibit a minimum in the neighbourhood of a closed proton and neutron shell. The fragments are then allowed to have a quadrupole distortion, and the value of the distortion parameter is calculated both from the previously obtained values of V_k and also from the Fong semi-empirical formula for the excitation energy of the fission products. The values, as a function of neutron excess, obtained by the two methods are in close agreement. E.J.Squires

3468 PROCESSES OF FRAGMENTATION AND FISSION IN INTERACTIONS BETWEEN HIGH ENERGY PARTICLES AND NUCLEI.
N.A.Perfilov, O.V.Lozhkin and V.P.Shamov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 1, 3-56 (Jan., 1960).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 1, 1-40 (July-Aug., 1960).

After an introduction on the "cascade-evaporation" model for nuclear reactions due to particles of energy 10^2-10^4 MeV, the remainder of the paper is devoted to fragmentation and fission in these reactions. Features of fragmentation that are discussed include energy dependence, charged particle multiplicity, fragmentation multiplicity, charge, energy, and angular distribution of fragments, neutron excess or deficiency of the fragments. Their interpretation is discussed in terms of a nuclear cascade process, evaporation and asymmetrical fission. No single one of these processes can explain all the observed features. Other possible mechanisms are considered, particularly the meson mechanism of energy transfer. Features of fission that are discussed include energy dependence of the cross-section, angular distribution and mass spectra of the fission fragments. The mechanism of the emission theory of fission is then explained in relation to the experimental data. Further details of the process are finally considered. These include the energy spectrum and number of charged particles emitted, ranges of definite fission fragments, angular correlations of the emitted particles with the fission fragments, and Monte Carlo calculations. A.Ashm

3469 THE RATE OF EMISSION OF SPONTANEOUS FISSION NEUTRONS BY NATURAL URANIUM.
D.J.Littler.
Reactor Science (GB), Vol. II, No. 1, 34 (Nov., 1959).

A correction to earlier results (Abstr. 3880 of 1952).

S.J.Goldsa

3470 DEMONSTRATION OF A CHAIN REACTION ON A MODEL. S.N.Sokolov and L.N.Érastov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 2, 377-9 (Feb., 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 2, 169-70 (July-Aug., 1960).

A simple device of different coloured lights demonstrates a neutron striking a nucleus and causing fission. The neutron repr sented by one light is shown to strike a nucleus by the nucleus lighting up. Two fission fragments, again represented by coloure lights, appear with three neutrons. The latter in turn produce fissions and fission fragments and the process is repeated once again. J.F.E

3471 ASYMMETRIC FISSION OF BISMUTH.
T.T.Sugihara, J.Roesmer and J.W.Meadows, Jr.
Phys. Rev. (USA), Vol. 121, No. 4, 1179-85 (Feb. 15, 1961).

An asymmetric mode of mass division in the mass region 66 was observed in the fission of Bi^{209} with 36 MeV protons. About 0.3% of the fissions contribute to this mode. At 58 MeV no evide for asymmetric fission (< 0.05% of total fissions) as a separate m could be found. The fission cross-sections at 36 and 58 MeV are 1.9 and 11.3 mb, respectively. The narrowness of the 36 MeV asymmetric peak leads to the suggestion that the asymmetric fiss of bismuth results from the fission of a single nuclear species an from a closed-shell effect, similar to the fine structure observed low-energy fission of heavy elements. This asymmetric fission considered to occur from states of relatively high excitation ener However, the possibility of asymmetric fission also occurring fr states of low excitation energy, whether following neutron fission observed with both 36 and 58 MeV protons is consistent with the r sults obtained by Fairhall (Abstr. 6156 of 1956) in the fission of b muth with 22 MeV deuterons.

3472 ON THE PRODUCTION OF Be^7, Mg^{28}, AND Ni^{66} IN TH SLOW NEUTRON FISSION OF U^{235}. J.C.Roy.
Canad. J. Phys., Vol. 39, No. 2, 315-25 (Feb., 1961).

The yields of 53-day Be^7 21.3-hour Mg^{28}, and 56.6-hour Ni^{66} from the slow neutron fission of U^{235} were investigated. Upper limits of 3×10^{-7}% and 4.2×10^{-9}% were set for the fission yield of Be^7 and Mg^{28} respectively. A fission yield of $2.0 \pm 1.0 \times 10^{-8}$% was found for the formation of Ni^{66}. These results are compared with the current knowledge of the frequency of triple fission of U^{2}

3473 CHARGE DISTRIBUTION IN THE FISSION OF URAN- IUM ISOTOPES INDUCED BY 20-40 MeV HELIUM IO
L.J.Colby, Jr and J.W.Cobble.
Phys. Rev. (USA), Vol. 121, No. 5, 1410-14 (March 1, 1961).

The primary yields of Br^{82}, I^{130}, La^{140}, Pr^{142}, and I^{135} were accurately determined for the medium-energy (20-40 MeV) helium ion-induced fission of U^{233}, U^{235}, and U^{238}. These accurate prima yield data are correlated with the constant-charge-ratio rule for nuclides away from the neutron shells and give a smooth, but diff ent, distribution curve for nuclides of 83 neutrons.

3474 HELIUM-ION-INDUCED FISSION CROSS SECTIONS C U^{233} AND U^{238} AND THE NUCLEAR RADII OF HEAVY ELEMENTS. L.J.Colby, Jr, M.L.Shoaf and J.W.Cobble.
Phys. Rev. (USA), Vol. 121, No. 5, 1415-22 (March 1, 1961).

New radiochemical data on the total fission cross-sections w obtained for U^{233} and U^{238}, which can be used to derive nuclear ra for these isotopes. This and certain accurate previous results on U^{235} and natural bismuth can be interpreted in terms of an r_0 valu of 1.41×10^{-13} cm, when $R_\alpha = 2.19 \times 10^{-13}$ cm, using the Weisskc square-well nuclear model. Further, the nuclear radii obtained b this analysis are also in good agreement with the radii obtained b others from alpha-particle scattering data with a similar model. diffuse-potential nuclear model proposed by Igo (Abstr. 1419 of 1 shows agreement with experiment in the lower energy range. Th agreement, however, is not observed with data for higher energie Certain features of the U^{233} fission curves are also discussed.

3475 ENERGY DISTRIBUTION OF THE FRAGMENTS OF TRIPLE U^{235} FISSION.
V.N.Dmitriev, L.V.Drapchinskii, K.A.Petrzhak and Yu.F.Romanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 556-62 (Sept., 1960). In Russian.

Data are presented on the energy distribution of the fragments of triple U^{235} fission. It is shown that the ratio of the triple to double fission probability does not depend on the ratio of the masses. Arguments are given which substantiate the relation $E_d = E_{tr} + E_\alpha$ where E_d and E_{tr} are the total energies of the double and triple fission fragments, E_α is the energy of a long-range α-particle. The mechanism of triple fission is discussed. [English translation in: Soviet Physics—JETP (USA)].

3476 ANGULAR DISTRIBUTION OF FISSION FRAGMENTS PRODUCED BY LOW-ENERGY NEUTRONS.
V.M.Strutinskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 781-93 (Sept., 1960). In Russian.

The angular distribution of fission fragments produced in the capture of low orbital momentum particles is considered. The spin of the target nucleus is taken into account. The effect of fluctuations of the transition-nucleus level distribution on the angular distribution of the fission fragments is also considered. [English translation in: Soviet Physics—JETP (USA)].

3477 THE AVERAGE NUMBER OF NEUTRONS FROM THE THERMAL FISSION OF Am^{241}.
V.I.Lebedev and V.I.Kalashnikova.
Atomnaya Energiya (USSR), Vol. 5, No. 2, 196 (1958). In Russian.

Using a parallel-plate ionization chamber containing a thin Am^{241} sample, the ratio of the average number of neutrons emitted per fission, induced by thermal neutrons, in Am^{241} relative to the number for U^{235}, was found to be 1.27 ± .01. [English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 90 (July, 1959).

C.J.Batty

Thermonuclear Reactions

3478 EFFECT OF MANY-BODY COLLISIONS ON THE RATE OF THERMONUCLEAR REACTIONS.
H.S.Taylor.
Phys. of Fluids (USA), Vol. 3, No. 6, 1032-3 (Nov.-Dec., 1960).

Examines whether the perturbation of the Maxwell tail (of the ion-velocity distribution in a plasma) due to collective phenomena is likely to affect the rates of thermonuclear reactions. Consideration of a typical case indicates that the effect is negligible.

H.N.V.Temperley

NUCLEAR POWER STUDIES

3479 METALLURGY AND ATOMIC ENERGY — DIFFICULTIES AND RESULTS ACHIEVED. M.Salesse.
Nukleonik (Germany), Vol. 2, No. 2, 79-83 (April, 1960). In French.

Discusses the French atomic energy programme, with particular reference to gas-cooled reactors with moderators of graphite, heavy water or BeO. Specific topics treated include: choice of a suitable Mg alloy for canning; work on sintered BeO; and high burn-up with metallic U. J.Thewlis

3480 SWEDISH INVESTIGATIONS ON UO_2 AS A REACTOR FUEL. R.Kiessling.
Nukleonik (Germany), Vol. 2, No. 5, 198-203 (Sept., 1960). In German.

A survey of Swedish work, under the headings: choice of UO_2 as a reactor fuel; preparation and properties of UO_2 powders; preparation of sintered UO_2 bodies; behaviour of UO_2 as a reactor fuel. The survey includes the results of the irradiation of Swedish UO_2 in the NRX and MTR reactors. J.Thewlis

3481 THE THERMAL NEUTRON SPECTRUM IN THE WWR-S REACTOR, BUCAREST.
H.Teutsch, S.Apostolescu and P.Timis.
Nukleonik (Germany), Vol. 2, No. 2, 41-3 (April, 1960). In German.

This spectrum was measured by a "time of flight" spectrometer with a 64-channel time analyser. The chopper consisted of two collimators on either side of two parallel rotating plates of cadmium. The time origin of this system was found absolutely to ±5μs by detecting chopped γ-rays (from the shut-down reactor) with a scintillation counter, in place of the spectrometer's BF_3 tube. The spectrum was found to be Maxwellian with a neutron temperature of 390 ± 17°K and moderator temperature of 297°K.

D.H.Lord

3482 MEASUREMENTS OF REACTIVITY IN THE BERLIN REACTOR B.E.R. J.R.Engel and R.Schröder.
Nukleonik (Germany), Vol. 2, No. 3, 88-90 (May, 1960). In German.

The reactivity of this reactor was determined for various volumes and concentrations of fuel, by measuring the period of the reactor with the help of two fission chambers. From these results reactivity diagrams were drawn that gave: the water, fuel volume, fuel mass and temperature coefficients of reactivity; the poisoning factor and the relative merits of the control rods.

D.H.Lord

3483 VALIDITY OF THE B_1 METHOD FOR FUEL CYCLE ANALYSIS. S.A.Hasnain and R.L.Murray.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 455-6 (Nov., 1959).

The conditions of validity of the two assumptions (1) separability of flux in space and time (2) representation of flux by the bare-equivalent flux shape are established in a method of the burn-up analysis of fixed fuel element reactors. J.F.Hill

3484 CALCULATION OF THE FERMI AGE AND LEAKAGE FACTOR OF HETEROGENEOUS LIGHT WATER REACTORS WITH THE MONTE-CARLO METHOD. W.Matthes.
Nukleonik (Germany), Vol. 2, No. 1, 21-31 (Jan., 1960). In German.

A Monte-Carlo programme which finds the Fermi age in these reactors is described. Taken into account are: elastic and inelastic scattering, capture, intermediate and fast fission; also given are the spatial distribution of the fast and slow neutrons. The programme is applied to six types of square lattice of cylindrical uranium rods with diameters of 1.5 and 3 cm, and volume ratios, $V(H_2O)/V(U)$, of 1, 2 and 3.5. The results from this are compared with those of Barkov (1957) and Kouts (1958). An enlarged programme gives the values of leakage factors, which are compared with the values given by the Fermi and Two-Group approximate models. D.H.Lord

3485 RESONANCE CAPTURE OF NEUTRONS IN A BUNDLE ARRANGEMENT OF FUEL ELEMENTS. G.Blässer.
Nukleonik (Germany), Vol. 2, No. 1, 31-6 (Jan., 1960). In German.

The resonance capture for neutrons in a stack of absorbing plates is calculated, using the Wigner approximation. The concept of effective surface area is introduced and the values obtained for this capture in plates are compared, on a basis of equal ratios of surface area to volume, with the experimental values of Hellstrand (Abstr. 8229 of 1958) for capture in bundles of rods. D.H.Lord

3486 EXPERIMENTAL MODEL FOR XENON POISONING IN A NUCLEAR REACTOR. K.Hecht.
Nukleonik (Germany), Vol. 2, No. 1, 37-8 (Jan., 1960). In German.

Water flows out of one vertical tube into another which has a tap at its bottom end. A constant flow of water enters the top of the upper tube through a tap. The height of water in this tube represents the flux in the reactor, the flow into the lower tube represents the iodine decay to xenon and the outward flow from the bottom tap the xenon decay and its destruction by neutron capture. J.F.Hill

3487 THE CONTINUOUS SOLUTION OF THE STATIONARY MULTI-GROUP DIFFUSION EQUATION OF A REFLECTED SPHERICAL REACTOR AND THE ADAPTATION OF THE CYLINDRICAL REACTOR TO THE SPHERICAL REACTOR.
F.Cap and H.Reimann.
Nukleonik (Germany), Vol. 2, No. 2, 47-54 (April, 1960). In German.

It is shown that the multi-group diffusion equations for spherical reactors with any number of reflectors can be rigorously solved by introducing rotated elliptical coordinates. In the stationary state the flux distribution is given by a series of "spheroid functions". The method is described which approximates a cylindrical reactor by a spherical one, also an empty reactor and one with a confocal reflector are dealt with for two groups.

D.H.Lord

3488 ON THE THEORY OF THE RESONANCE ABSORPTION OF NEUTRONS IN HETEROGENEOUS REACTORS. I.
A.Müller.
Nukleonik (Germany), Vol. 2, No. 2, 54-67 (April, 1960). In German.

A set of integral equations is derived from the energy dependent transport equation for reactors with homogeneous cells. Then various approximations for the collision probability (e.g. Wigner's) and their improvement are discussed. The equations are solved and

resonance integrals calculated by iteration and the use of the N–R approximation. Finally the N–R I A approximation is introduced and the effect of temperature on the resonance integral given.

D.H.Lord

3489 ON THE THEORY OF THE RESONANCE ABSORPTION OF NEUTRONS IN HETEROGENEOUS REACTORS. II. A.Müller.

Nukleonik (Germany), Vol. 2, No. 2, 67-73 (April, 1960). In German.

To illustrate the convergence of the approximate methods described in Pt I (see preceding abstract), the unfavourable case of the broad resonance absorption line (E_r = 6.68 eV) of U^{238} in a single UO_2 rod is worked out by these various methods. The complete treatment of a single UO_2 rod is given and the transformations of these results to single UO_2 plates and spheres and to a periodic lattice of UO_2 plates is described. D.H.Lord

3490 ON THE POSSIBLE INSTABILITY OF THE POWER DENSITY AND XENON CONCENTRATION IN A LARGE THERMAL POWER REACTOR. H.Märkl.

Nukleonik (Germany), Vol. 2, No. 3, 90-100 (May, 1960). In German.

The oscillations of the neutron flux and xenon concentration due to feedback between fluctuations in the power density and the xenon production are studied. The oscillations are described in a set of linearized equations which are solved by a Laplace transformation and matrix reduction. The dependence of stability on the reactor dimensions and flux magnitude is investigated for cylindrical natural uranium–heavy water reactors. D.H.Lord

3491 THE NEUTRON FLUX FORMED BY THE INTRODUCTION OF SOURCE NEUTRONS INTO A PURE MULTIPLYING MEDIUM. A.Y.Özemre.

Nukleonik (Germany), Vol. 2, No. 3, 100-5 (May, 1960). In French.

Diffusion theory is used to study the flux created in a homogeneous medium in which there is, initially, no production of fission neutrons. The problem is considered for the cases of one resultant neutron energy group and of several resultant neutron groups. In the first case, the effect of delayed neutrons is considered. Using one group theory, the flux distribution is obtained for parallelepipeds, spheres and cylinders. In the multigroup treatment a general expression for the flux distributions is obtained. The distribution in number, space and time of the source neutrons can be made arbitrary in the methods described.

A.J.Salmon

3492 NEUTRON SPECTRUM IN HETEROGENEOUS PLATE REACTORS. II. W.Häfele.

Nukleonik (Germany), Vol. 2, No. 6, 240-6 (Nov., 1960). In Germa

For previous part see Abstr. 11506 of 1959. A generalization is given which makes the transition between the neutron spectra in an infinite, homogeneous reactor calculated with the heavy gas mo and the spectra in a finite, heterogeneous, laminar reactor.

D.H.Lo

3493 THE EFFECT OF CONTROL RODS IN A THERMAL REACTOR USING TWO-GROUP THEORY. R.Frohlic

Nucleonik (Germany), Vol. 2, No. 5, 192-8 (Sept., 1960). In Germa

The effect of control rods parallel to the axis of a cylindrical reactor is calculated on the standard two-group theory for the Karlsruher experimental reactor FR2. Three cases are considere namely when the cadmium control rods are respectively filled wit air, water and heavy water and the reactivity controlled is found a a function of rod size. The results are compared with a correspo ing one-group calculation. J.F.Hi

3494 THE TREND OF REACTOR CONTROL. UNIQUE CONTROL BY TEMPERATURE. J.Weill.

Nuclear Electronics Conference, Paris, 1958. Vol. I (see Abstr. 12719 of 1960) p. 335-42. In French.

It is shown that a reactor may be started safely by temperatu dependent control if a residual power (e.g. 100 W) is ensured by neutron sources, if the rate of withdrawal of the absorbing rods is very small and if cooling is absent before divergence and then ma dependent on temperature. W.G.Str

3495 TECHNIQUES USED TO EVALUATE THE DYNAMIC PERFORMANCE OF A NATURAL RECIRCULATION BOILING WATER REACTOR. J.A.De Shong, Jr.

Nuclear Electronics Conference, Paris, 1958. Vol. I. (see Abstr. 12719 of 1960) p. 359-69.

The dynamic performance of a reactor is that of a zero-power reactor modified by power feedback effects. A block diagram of a reactor model is given, with the transfer functions for the blocks. In measurements of flux, signal-to-noise ratios less than 1 can be met due to boiling noise. The waveform of the flux signal plus no is complex. A wave analyzer is described, in which the flux signa from an ion chamber is correlated with a reactivity input.

W.G.Str

ATOMIC AND MOLECULAR PHYSICS

3496 QUANTUM-MECHANICAL CALCULATION OF HARMONIC OSCILLATOR TRANSITION PROBABILITIES IN A ONE-DIMENSIONAL IMPULSIVE COLLISION.
K.E.Shuler and R.Zwanzig.
J. chem. Phys. (USA), Vol. 33, No. 6, 1778-84 (Dec., 1960).

Quantum-mechanical vibrational transition probabilities $P_{i\to f}(\epsilon)$ for harmonic oscillators, undergoing impulsive hard sphere collisions along the line of centres with an incident atom with relative kinetic energy ϵ, have been computed by a machine (IBM-704) solution of the relevant Schrödinger equation. Curves for $P_{i\to f}(\epsilon)$ over a range of ϵ are presented for initial (i) and final (f) vibrational oscillator states i, f = 0, 1, 2, and 3. It is shown that this model of an inelastic collision gives rise to appreciable vibrational transitions $v(i) \to v(f)$ with $|\Delta v| > 1$ (in addition to $|\Delta v| = 1$) in contrast to the Landau–Teller–Herzfeld adiabatic, first-order perturbation treatment which permits only transitions with $\Delta v = 1$. This result is discussed in relation to the dissociation of diatomic molecules and to the adsorption of atoms on solids. Averaged transition probabilities $\bar{P}_{i\to f}(T)$ are computed for an incident beam of particles with a Maxwellian velocity distribution. It is pointed out that such averaged transition probabilities may give a misleading impression of the efficiency of translational-vibrational energy transfer if the $P_{i\to f}(\epsilon)$ show a resonance type of behaviour, i.e. a strong dependence of $P_{i\to f}(\epsilon)$ on ϵ over a small interval of ϵ.

3497 SELECTION RULES FOR SPIN–ORBIT MATRIX ELEMENTS FOR THE CONFIGURATION f^n.
A.G.McLellan.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 419-22 (Sept., 1960).

Group-theoretical analysis gives the selection rules for the Racah quantum numbers W and U. J.Hawgood

3498 SUM RULE FOR TRANSITION PROBABILITIES.
W.Clinton.
J. chem. Phys. (USA), Vol. 34, No. 1, 273-5 (Jan., 1961).

A sum rule is derived for the spontaneous emission transition probability. In particular it is shown that for an atom

$$\sum_{m}^{\infty} W_{nm} = Z\rho_n(0),$$

where W_{nm} is the spontaneous emission transition probability, Z is the nuclear charge, and $\rho_n(0)$ is the electron density of the nth electronic state evaluated at the nucleus.

ATOMS

3499 WORK ON ATOMIC SPECTROSCOPY IN THE U.S.S.R.
S.É.Frish.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 1, 3-12 (May, 1959). In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 2(68), No. 3, 343-51 (May-June, 1959).

The main fields of research on atomic spectroscopy in the U.S.S.R. are reviewed. These are (1) study of elementary processes of spectral emission; (2) determination of nuclear moments by optical spectroscopy; (3) emission from glowing gases and vapours; (4) use of light wavelengths for measurement; and (5) application to analytical problems. A large number of references to Russian work, mainly over the last ten years, is given. G.I.W.Llewelyn

3500 DERIVATION OF THE FERMI–THOMAS EQUATION.
A.A.Broyles.
Amer. J. Phys., Vol. 29, No. 2, 81-3 (Feb., 1961).

A derivation of the Fermi–Thomas equation for a neutral atom is presented to show it as an approximation to the usual Hartree and WKB approximations.

3501 THERMODYNAMIC FUNCTIONS OF THE RELATIVISTIC THOMAS–FERMI ATOM AT LOW TEMPERATURES.
V.S.Mathur.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 391-9 (March, 1960).

The thermodynamic functions at low temperatures and high pressures are obtained in terms of the boundary and initial parameters of the Thomas–Fermi and perturbation equations. These functions are expressed in terms of a parameter y_0 which depends on the density of the material. The final results are valid only when the densities are very high, such as those occurring in the interiors of white dwarf stars.

3502 THE SELECTION RULES OF THE ELECTRON TRANSITION WITH VARIOUS TYPES OF COUPLING.
Ya.I.Vizbaraite, V.I.Chiplis and A.P.Yutsis.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1101-3 (Dec. 11, 1960). In Russian.

The one-electron electric multipole transitions from the configuration 1^q1^1, having LS coupling in 1^q, are considered. The angular momenta L.S. of 1^q and the one-electron angular momenta 1^1s^1 can through various types of coupling give the resultant J. In order to characterize these couplings a pair of so-called intermediate quantum numbers is introduced and the expression for the intensity of the line of the transition $1^q1' - 1^q1''$ containing the tensor operator of the electric 2^K-field, is set up. Using special mathematical techniques, selection rules for the transition are obtained and are tabulated. A discussion of the results and of their practical significance is given. [English translation in: Soviet Physics-Doklady (USA)]. F.Herbut

3503 VARIATIONAL CALCULATION OF MAGNETIC HYPERFINE INTERACTION. NITROGEN ATOM.
T.P.Das and A.Mukherjee.
J. chem. Phys. (USA), Vol. 33, No. 6, 1808-13 (Dec., 1960).

A variational method, employing the unrestricted Hartree–Fock approximation, is proposed for the calculation of isotropic magnetic hyperfine constants in paramagnetic atoms and ions with unpaired electrons in non-S states and in free radicals. The method is applied to the ground state of the nitrogen atom. The N^{14} hyperfine constant in the ground state is calculated to be +7.3 Mc/s as compared to the recent experimental value of +10.4509 ± 0.0003 Mc/s. Reasons for the discrepancy are discussed.

3504 COMPOSITION OF THE ELECTRONIC STATES OF Nd(IV) AND Er(IV). B.G.Wybourne.
J. chem. Phys. (USA), Vol. 34, No. 1, 279-81 (Jan., 1961).

The eigenvectors of the electronic states of the trivalent neodymium and erbium ions are tabulated for use in calculating the crystal field and Zeeman splittings of the ground and excited states.

3505 α^3 CORRECTIONS TO HYPERFINE STRUCTURE IN HYDROGENIC ATOMS. D.E.Zwanziger.
Phys. Rev. (USA), Vol. 121, No. 4, 1128-42 (Feb. 15, 1961).

The α^3 term in the ratio of the hyperfine splitting in the 2S state of the one-electron atom to the hyperfine splitting in the 1S state is recalculated, and a new theoretical value of this ratio is obtained which is in agreement with the experimental value, thereby, eliminating a previously reported discrepancy. The calculation consists in the evaluation of the low-momentum parts, of order α^3 h.f.s. of the expression for the lowest-order radiative level shift in the bound interaction representation with external Coulomb and magnetic dipole fields. By rearranging the terms so as to display the gauge invariance of the matrix elements with respect to the external potentials, considerable simplicity is achieved, and the formulae are easily interpreted as a generalization of the expression for the lowest order Lamb shift. The contribution from soft photon intermediate states is obtained by an extension of the method developed by Schwartz and Tiemann (Abstr. 4289, 6155 of 1959) for evaluating the Bethe logarithm, and an appendix contains a tabulation of twelve analogous integrals which were integrated numerically, and which may be of use elsewhere. The calculated value of the ratio is $\frac{1}{8}$ (1.000 034 5 ± 0.000 000 2) which agrees with the experimental values for hydrogen: $\frac{1}{8}$ (1.000 034 6 ± 0.000 000 3), and deuterium: $\frac{1}{8}$ (1.000 034 2 ± 0.000 000 6).

3506 STRONG COUPLING IN OPTICALLY ALLOWED ATOMIC TRANSITIONS PRODUCED BY ELECTRON IMPACT. M.J.Seaton.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 174-83 (Jan., 1961).

Optically allowed transitions have long-range interaction potentials, behaving asymptotically as s_l/r^2, where s_l is proportional to the dipole matrix element. In calculating cross-sections many angular momentum states l must therefore be considered.

When the coupling is strong the usual Born approximation leads to violations of conservation conditions which are serious for the smaller values of l. Three variants of the first Born approximation are considered: I is the Born approximation for the total scattering amplitude, II the Born approximation for the reactance matrix and III (suggested by Percival) the Born approximation for the proper phase of the scattering matrix. Approximations II and III satisfy conservation conditions and make some allowance for processes such as $a \rightarrow a' \rightarrow a$, $a \rightarrow a' \rightarrow a''$ and of $a \rightarrow a''$ competing with $a \rightarrow a'$. Considering the case of exact resonance, and replacing the potentials by their asymptotic forms, one obtains equations for which exact analytic solutions may be obtained. The exact solutions are compared with those obtained using approximations I, II and III.

3507 THE EVALUATION OF PARTIAL WAVE INTEGRALS IN THE BORN APPROXIMATION. M.J.Seaton.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 184-91 (Jan., 1961).

The Born partial wave integrals may be evaluated on making a harmonic analysis of the integrals occurring in the Born total scattering amplitude. This provides a convenient method for numerical evaluation of the partial wave integrals. The paper includes the proofs of an addition theorem for solid harmonics and a multiplication theorem for spherical Bessel functions.

3508 THE CALCULATION OF BORN PARTIAL WAVE INTEGRALS FOR SOME TRANSITIONS IN H PRODUCED BY ELECTRON IMPACT.
J.Lawson, W.Lawson and M.J.Seaton.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 192-8 (Jan., 1961).

Using methods described in a companion paper by Seaton (see preceding abstract), the partial wave integrals are calculated for transitions involving the states 1s, 2s and 2p.

3509 THE CALCULATION OF ELECTRON–HYDROGEN COLLISION CROSS-SECTIONS USING THE BORN APPROXIMATION FOR THE REACTANCE MATRIX.
V.M.Burke and M.J.Seaton.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 199-212 (Jan., 1961).

In a companion paper Lawson, Lawson and Seaton (see preceding abstract) calculated the Born R matrix for H 1s, 2s and 2p. Using these results the transmission matrix is calculated from $T = -2iR/(1 - iR)$. In another companion paper Seaton showed that this should give results which are better than those obtained from the Born approximation for the total scattering amplitude. The following cross-sections were calculated: elastic (1s–1s, 2s–2s, 2p–2p); momentum loss (1s–1s, 2s–2s, 2p–2p, 2s–2p); inelastic (1s–2s, 1s–2p m_l); transitions between fine structure levels ($2s_{1/2}$–$2p_{1/2}$, $2s_{1/2}$–$2p_{3/2}$, $2p_{1/2}$–$2p_{3/2}$). Comparison with experiment shows the results for 1s–2p to be much better than those obtained from the usual Born total amplitude.

HYPERFINE STRUCTURE OF HYDROGEN: CORRECTION FORMULA. See Abstr. 3180

3510 LINE WIDTHS IN THE ELECTRON PARAMAGNETIC RESONANCE SPECTRUM OF GASEOUS ATOMIC HYDROGEN. R.M.Mazo.
J. chem. Phys. (USA), Vol. 34, No. 1, 169-75 (Jan., 1961).

A theory of the paramagnetic linewidth in gaseous atomic hydrogen, based on the theory of Baranger, and on an expansion of the spin correlation function in powers of the density, is presented. To the approximations considered, the line shape is Lorentzian, the linewidth is proportional to the H atom density, and the relevant cross-section involves an interference between the scattered amplitudes from the singlet and triplet potential curves. Comparison with experiment yields a velocity-averaged cross-section of 28.3×10^{-16} cm^2 at 325° K. This value is compared with other estimates found in the literature.

3511 WAVELENGTH SHIFT OF SPECTRUM LINES IN SPARK SPECTRA.
A.Bardocz, U.M.Vanyek and T.Voros.
J. Opt. Soc. Amer., Vol. 51, No. 3, 283-8 (March, 1961).

The subject of the paper is a study of the wavelength shift of the spectrum lines in transient spark discharges. Since the wavelength shift is a function of the excitation energy, the investigations were carried out by time-resolved spectra. The time resolution was effectuated with the aid of a rotating mirror, which images the spark produced by an electronically controlled high-precision source on the slit of a stigmatic spectrograph. The spectra of the elements Zn, Cd, Hg, and Mg of the second column of the periodic system were investigated. Lines corresponding to different electronic transitions exhibit different wavelength shifts. Measurements of the wavelength shifts are given and agree with the magnitude of the shifts estimated theoretically.

3512 ISOTOPE SHIFT CALCULATIONS FOR NON-UNIFORM CHARGE DISTRIBUTIONS. A.R.Bodmer.
Nuclear Phys. (Internat.), Vol. 21, No. 2, 347-52 (Nov. (5), 1960).

It is shown that recent calculations by Meligy (Abstr.4169, 11507 of 1960) of the charge-dependent isotope shift for the special case of a trapezoidal nuclear charge distribution are in agreement with previous results, obtained by the author, which are applicable to any charge distribution whatever its shape, both sets of calculations allowing for the distortion of the electron wave-function by the nuclear charge distribution. A discussion of Meligy's numerical results is given which indicates that previous conclusions about the isotope shift discrepancy remain essentially unchanged.

3513 FORBIDDEN TRANSITION L_1 M_1 IN THE SPECTRUM OF PLATINUM (78). A.N.Nigam and K.S.Srivastava.
J. sci. industr. Res. (India), Vol. 19B, No. 3, 111-12 (March, 1960).

A line of wavelength 1167.3 X.U. in the X-ray spectrum of Pt is ascribed to the L_1 M_1 transition. G.I.W.Llewelyn

3514 SOFT X-RAY EMISSION SPECTRA OF SOME TRANSITION AND NOBLE METALS. C.Curry and D.J.McNeill.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 791-4 (Nov., 1960).

Presents information about intensity distributions in the $N_{II,III}$ spectra of rhodium, palladium and silver, and about the $M_{II,III}$ spectra of copper and nickel. The wavelength region 150-250 A was photographed with a 1 m concave, grazing-incidence spectrograph. K.A.Thomas

3515 DETECTION OF DOUBLE RESONANCE BY FREQUENCY CHANGE: APPLICATION TO Hg^{201}. R.H.Kohler.
Phys. Rev. (USA), Vol. 121, No. 4, 1104-11 (Feb. 15, 1961).

A new type of double-resonance experiment that depends on wavelength effects rather than on polarization effects is discussed. Incident polarized light is replaced by incident light of wavelength coincident with just one component of the structure to be measured. The analyser is replaced by a cell of gas that absorbs just that same component and lets the others pass. Magnetic resonance from the excited component to one of the others is monitored by increases in the light transmitted through the absorbing gas. This experiment requires that the Doppler width be smaller than the structure. This method was first applied to measure the hyperfine structure of the $^3P_1$ state of Hg^{201}. The incident light and absorbing gas were both supplied by separated Hg^{198}, whose resonance line coincides naturally with one component of the Hg^{201} hyperfine structure. Measurement of Hg^{201} is discussed in detail. The following h.f.s. intervals were found: $f(\frac{1}{2} \leftrightarrow \frac{3}{2}) = 7551.613 \pm 0.013$ Mc/s and $f(\frac{3}{2} \leftrightarrow \frac{5}{2}) = 13\,986.557 \pm 0.008$ Mc/s. The magnetic dipole and electric dipole interaction constants, calculated without quadratic h.f.s. corrections, are $a = -5454.569 \pm 0.003$ Mc/s, $b = -280.107 \pm 0.005$ Mc/s. Means for applying the method when there is no isotope coincidence are given. This new method is compared with the polarization technique and is found to give signal-to-noise ratios that are orders of magnitude higher.

3516 EXCITATION OF THE 1s–2p TRANSITION OF ATOMIC HYDROGEN BY PROTON AND ALPHA-PARTICLE IMPACT. D.R.Bates.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 59-64 (Jan., 1961).

Using the distortion approximation the cross-sections for the collision processes

$$H(1s) + H^+ (\text{or } He^{2+}) \rightarrow H(2p) + H^+ (\text{or } He^{2+})$$

are evaluated at H^+ energies between 10 keV and $100\sqrt{10}$ keV (or He^{2+} energies between 40 keV and $400\sqrt{10}$ keV). It is found that the effect of distortion is not as much as in the case of

$$H(1s) + H^+ (\text{or } He^{2+}) \rightarrow H(2s) + H^+ (\text{or } He^{2+}).$$

Optically allowed transitions are in general likely to be less influenced by distortion than are optically forbidden transitions.

3517 DEDUCTION OF THE RADIAL EQUATIONS FOR COLLISIONS BETWEEN ELECTRONS AND ATOMS.
L.A.Vainshtein and I.I.Sobel'man.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 767-75 (Sept., 1960). In Russian.

Radial equations are deduced which describe the excitation of an arbitrary level of a many-electron atom, allowing for nonortho-

gonality of the wave-functions of the external and optical electrons. The well-known non-uniqueness which appears when approximate atomic wave-functions are used is discussed. An approximate form of the equations is proposed; it is based on neglection of terms which simultaneously contain nonorthogonality integrals and higher multipole interactions. In this approximation the non-uniqueness dissapears if semi-empirical wave-functions for the optical electron are employed. [English translation in: Soviet Physics–JETP (USA)]

3518 ON WAVE FUNCTIONS FOR THE PROBLEM OF ELECTRON AND X-RAY SCATTERING BY HELIUM ATOMS. W.Kołos.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 1, 67-70 (1960).

Numerical values of differential scattering cross-sections of the helium atom are calculated. Two different types of wave-function are used to study the dependence of the cross-section on the form of the assumed wave-function, and in particular, on the correlation of the atomic electrons. It is concluded that electron correlation does not significantly influence calculated cross-sections in cases for which the Born approximation is valid. It is also concluded that the minimum energy criterion of trial wave-functions is not necessarily a valid guide for the choice of wave-functions for cross-section calculations. P.M.Parker

3519 A NOTE ON THE FIRST BORN APPROXIMATION IN COLLISIONS OF ELECTRON WITH HELIUM. S.Huzinaga.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 562-8 (April, 1960).

The dependence of the results of the first Born approximation on the choice of the approximate wave-functions for helium is examined in collision processes of electrons with helium. So far the wave-function

$$\Psi \sim \exp\{-(27/16a_0)(r_1 + r_2)\}$$

has been used almost exclusively as the analytical wave-function of the ground state of helium. In this paper

$$\Psi \sim \exp\{-(\zeta/a_0)r_1-(\zeta'/a_0)r_2\} + \exp\{-(\zeta'/a_0)r_1-(\zeta/a_0)r_2\}$$

is used. It is found that the theoretical results are quite sensitive to the values of the parameters ζ and ζ'; with suitable choices of ζ and ζ', considerable improvement is obtained within the first Born approximation.

3520 OPTICAL-MODEL ANALYSIS OF LOW-ENERGY ELECTRON– HYDROGEN SCATTERING. B.A.Lippmann and H.M.Schey.
Phys. Rev. (USA), Vol. 121, No. 4, 1112-19 (Feb. 15, 1961).

The electron–hydrogen scattering problem is reduced to an equivalent one-body problem by the use of an optical-model potential. Two effects are examined quantitatively: the effect of the Pauli principle and the elastic scattering in the triplet state. For a long-range optical potential, the effect of the Pauli principle is small; however, for a short-range optical potential, the Pauli principle changes the zero-energy cross-section by an order of magnitude. The elastic scattering results, though in agreement with many previous calculations, are disappointing. It is argued that this is due to an inconsistent application of the optical model, and that a more consistent use of the optical model is equivalent to (and therefore provides a derivation for) the heuristic procedure, used by Martin, Seaton, and Wallace, which yields scattering lengths close to the Rosenberg, Spruch, and O'Malley bounds.

3521 SCATTERING OF METASTABLE HELIUM ATOMS IN HELIUM, NEON AND ARGON. G.M.Smith and E.E.Muschlitz, Jr.
J. chem. Phys. (USA), Vol. 33, No. 6, 1819-25 (Dec., 1960).

Total collision cross-sections for the scattering of metastable 2^3S and 2^1S He atoms in helium, neon, and argon were measured using a thermal-energy atomic beam in which a fraction of the helium atoms are excited by electron bombardment. The excited particles are detected by measuring the secondary electron emission from metal surfaces. The cross-sections for the scattering of the triplet atoms are larger than for the singlet in each case. For neon the difference is considerably greater than the estimated experimental error, indicating a large difference in the interaction potentials.

3522 THE STOPPING POWERS OF ATOMS. A.Dalgarno.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 422-4 (Sept., 1960).

It is shown that these average excitation energies can be computed to within about 1% by an approximate analytic fit to a sequence of quantities derived from the wave-functions. J.Hawgood

3523 THE PROBLEM OF THE DOUBLE TABLE OF ATOMIC WEIGHTS AND THE REPORT OF THE COMMISSION FOR ATOMIC WEIGHTS OF THE INTERNATIONAL UNION FOR CHEMISTRY FOR THE YEAR 1954-1955. V.Caglioti.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 280-2 (1957). In Italian.

The author recalls the difficulties involved in the accurate mass spectrographic determination of the fluorine mass, and suggests that at least for the moment the conventional oxygen mass, as adopted by the IUPAC, should be retained. G.Martelli

Isotopes

3524 ISOTOPE SEPARATION BY THERMAL DIFFUSION IN THE LIQUID PHASE. K.F.Alexander.
Fortschr. Phys. (Germany), Vol. 8, No. 1-2, 1-41 (1960). In German.

Review article, giving an account of the general isotope separation theory, and the theory of the thermal diffusion column as applied to liquids, a discussion of the so far unsuccessful attempts to deduce the value of the thermal diffusion coefficient α in liquids, and a summary of the rather few experimental results. Attention is drawn to the fact that in nearly all cases so far examined the α for liquids is considerably larger than its theoretical maximum value for gases (i.e. for the hard-sphere gas model). As an example, the separation of the isotopes Br^{79}–Br^{81} is discussed. For liquid C_6H_5Br, $\alpha = 0.04$, whereas the hard-sphere gas value is 0.0056 and the actual value of gaseous HBr is 0.002. Although liquid has the disadvantage of a lower mass diffusion coefficient and a higher thermal conductivity, the larger α makes it more favourable, especially with regard to plant size; even the power consumption is somewhat lower. H.London

3525 SOME PROBLEMS ARISING FROM THE EVACUATION OF A CASCADE FOR ISOTOPE SEPARATION BY GAS DIFFUSION. R.Doré.
Vide (France), Vol. 14, 183-96 (July-Aug., 1959). In French and English.

The vacuum technique required for a cascade process in the separation of the U isotopes (using UF_6) is discussed. Particular attention is paid to the possibility of UF_6 reacting with water vapour and with atomic hydrogen. R.Schnurmann

3526 SPECTRAL ANALYSIS OF ISOTOPIC COMPOSITION. A.N.Zaidel'.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 1, 123-34 (May, 1959). In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 2(69), No. 3, 428-35 (May-June, 1959).

Methods recently developed independently in several countries for determination of isotopic composition using atomic spectra are reviewed, results obtained on hydrogen, helium, lithium, lead and uranium isotopes being presented. G.I.W.Llewelyn

ISOTOPIC COMPOSITION OF SILVER IN AN IRON METEORITE. See Abstr. 2608

MASS SPECTROMETER FOR THE ISOTOPIC ANALYSIS OF LITHIUM. See Abstr. 3023

Mesic Atoms

3527 CHARGE DISTRIBUTION IN NUCLEI AND ENERGY LEVELS OF μ-MESONIC ATOMS. G.E.Pustovalov and M.S.Krechko.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 337-45 (Nov. (1), 1960).

The $2P_{3/2} \rightarrow 1S_{1/2}$ transition energies of μ-mesic atoms are calculated using Hofstadter's nuclear charge distribution. Numerical solutions of the Schrodinger equation for μ-mesic atoms with uniform charge distribution inside a sphere of radius R_0 are used as zero-order approximation. Corrections due to modifications of uniform charge distribution and relativistic effects are taken into account by perturbation theory. It is shown that the trapezoidal and the smoothed uniform (Fermi type) models, which are equivalent for electron scattering, are not equivalent for the determination of the

$2P_{3/2} \rightarrow 1S_{1/2}$ transition energy of μ-mesic atoms. Agreement between the experimental transition energies and those calculated for the smoothed uniform model is satisfactory for heavy μ-mesic atoms. As for light mesic atoms, the value r_0 occurring in the formula for the uniform equivalent model radius $Re_{ff} = r_0 A^{1/3} \times 10^{-13}$ cm and determined from the experimental transition energy values of μ-mesic atoms proves to be smaller than that obtained from electron scattering.

3528 SHELL MODEL CALCULATIONS OF THE HYPERFINE EFFECT IN μ-MESON CAPTURE. H.Überall.
Phys. Rev. (USA), Vol. 121, No. 4, 1219-25 (Feb. 15, 1961).

Numerical values for the difference in μ-meson capture rates from the two hyperfine states of a mesonic atom are obtained for F^{19}, Al^{27} and P^{31}, employing the simple Mayer–Jensen version of the shell model for Al^{27} and P^{31}, and an intermediate coupling version for F^{19}. In all these cases, considerably larger values are obtained than those found in previous estimates, thus rendering experiments more feasible. In view of the consequences of atomic conversion on the observation of the capture-rate differences, conversion effects in the rate and asymmetry of μ-meson decay electrons are discussed. also.

MOLECULES

3529 POTENTIAL ENERGY CURVES FOR OH.
R.J.Fallon, I.Tobias and J.T.Vanderslice.
J. chem. Phys. (USA), Vol. 34, No. 1, 167-8 (Jan., 1961).

Potential energy curves for four of the bound states of OH are calculated by the Rydberg–Klein–Rees method. Various mechanisms to explain the anomalously high population of the v' = 2 and 3 levels of the $A^2\Sigma^+$ state are discussed.

3530 THE CONSTANTS OF THE $^2\Pi$–$^2\Pi$ OH BANDS.
L.Wallace.
Astrophys. J. (USA), Vol. 132, No. 3, 894-7 (Nov., 1960).

Observations obtained at Yerkes Observatory of the 8–3 and 9–4 OH bands in the night airglow show that the observed rotational constants B_8 and B_9 and the splitting constants Y_8 and Y_9 differ markedly from those extrapolated from laboratory determinations with $v \leq 6$. Other observations in the literature have also been reduced to obtain constants for v = 7, 8, and 9.

3531 ON PAULING'S THEORY OF ALKALI HALIDE MOLECULES. Y.P.Varshni and R.C.Shukla.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 794-7 (Nov., 1960).

A potential energy function suggested by Pauling [Proc. Nat. Acad. Sci. India A, Vol. 25, Pt 1 (1956)] was used to determine rotational constants, α_e, and anharmonicity constants, $\omega_e x_e$, for alkali halide molecules. These calculated values are found to be higher than the experimental values, and it is concluded that the Pauling model is not fully satisfactory. W.J.Orville-Thomas

3532 ATTEMPT AT A THEORETICAL INTERPRETATION OF SPECTRAL PERTURBATIONS OF HCl–A GASEOUS MIXTURES. G.C.Turrell.
J.Rech. Cent. Nat. Rech. Sci. (France), No. 51, 123-30 (June, 1960). In French.

A theoretical treatment shows that the appearance of the Q-branch of the rotation-vibration spectrum of HCl in presence of argon may be explained by (1) a quadrupole moment of HCl and (2) by a short-range overlap moment due to distortion of the electron distribution. Calculated and experimental values of the intensity of the Q-branch are compared for pressures up to 80 atmospheres and for T = 193-513° K. This shows that (2) is the major effect.
G.F.Lothian

3533 THE PURE VIBRATIONAL SPECTRA OF DIATOMIC HOMOPOLAR MOLECULES. N.I.Ionescu-Pallas.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 2, 107-11 (1957). In Roumanian.

The spectrum of vibrational energy levels of a non-rotating, diatomic, homopolar molecule was studied using a W.K.B. approximation, with a Morse potential. The results are compared with those of a Heitler–London calculation for the hydrogen molecule.
E.F.W.Seymour

3534 DEVELOPMENTS IN MOLECULAR SPECTROSCOPY IN THE U.S.S.R. B.S.Neporent.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 1, 13-29 (May, 1959). In Russian.

Discusses advances in electronic, vibrational and rotational molecular spectroscopy, and also the development of methods and equipment. Only the basic investigations are examined but references are given to works citing the complete literature on each subject. [English translation in: Soviet Physics–Uspekhi (USA), Vol. 2, No. 3, 352-64 (May-June, 1959)]. K.A.Thomas

3535 TEMPERATURE VARIATION OF THE LINEWIDTH IN NONRESONANT MICROWAVE ABSORPTION.
J.E.Boggs, A.P.Deam and J.M.King.
J. chem. Phys. (USA), Vol. 33, No. 6, 1852-5 (Dec., 1960).

The linewidth parameter $\Delta\nu/p$ for nonresonant microwave absorption in CH_3Cl and in $CHCl_2F$ was determined at five temperatures between 10° and 150° C from cavity measurements of dielectric dispersion in the gases as a function of pressure at a frequency of 402 Mc/s. The linewidth is found to be proportional to $T^{-1.5}$, as opposed to the $T^{-1.0}$ dependence predicted by Anderson's theory of collision broadening.

3536 MICROWAVE SPECTRUM OF CHLORINE DIOXIDE. I. ROTATIONAL ASSIGNMENT.
R.F.Curl, Jr, J.L.Kinsey, J.G.Baker, J.C.Baird, G.R.Bird, R.F.Heidelberg, T.M.Sugden, D.R.Jenkins and C.N.Kenney.
Phys. Rev. (USA), Vol. 121, No. 4, 1119-23 (Feb. 15, 1961).

The microwave spectrum was investigated and several rotational transitions assigned. The resulting rotational constants (in Mc/s) are:

$Cl^{35}O_2$: A = 52 072, B = 9952, C = 8332;
$Cl^{37}O_2$: A = 50 725, B = 9952, C = 8295.

These constants are limited in precision by the presence of hyperfine structure which has been only approximately treated. The structural parameters of chlorine dioxide as obtained from the rotational constants are $r_{Cl-O} = 1.473 \pm 0.01$ A; $< O - Cl - O = 117° 36' \pm 1°$. Approximate hyperfine constants are given.

3537 THE MICROWAVE SPECTRA OF SOME SUBSTITUTED ACETYLENES.
W.Zeil, M.Winnewisser, H.K.Bodenseh and H.Buchert.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 1011-13 (Nov., 1960). In German.

Rotational constants B_0 are measured for the symmetric-top molecules tertiary butyl acetylene, tertiary butyl acetylene-d, and tertiary butyl chloroacetylene containing both Cl^{35} and Cl^{37}. The tertiary butyl chloroacetylene was made for the first time for this work. The rotational constants A_0, B_0 and C_0 are also determined for the asymmetric-top molecule, phenyl acetylene. The corresponding moments of inertia agree with the expected planar configuration. Brief practical details are given. J.Sheridan

3538 MICROWAVE SPECTRUM OF CIS-DIFLUOROETHYLENE. STRUCTURES AND DIPOLE MOMENTS OF FLUOROETHYLENES. V.W.Laurie.
J. chem. Phys. (USA), Vol. 34, No. 1, 291-4 (Jan., 1961).

The microwave spectrum of cis-difluoroethylene, HFC = CHF, was investigated in the region 17-36 kMc/s. Observed rotational constants (Mc/s) for the ground vibrational state of $C_2{}^{12}H_2F_2$ are $a_0 = 21103.31$, $b_0 = 5930.35$, $c_0 = 4622.27$; for $C^{13}C^{12}H_2F_2$, $a_0 = 20752.10$, $b_0 = 5900.17$, $c_0 = 4586.92$. From these constants a structure is obtained with $r_{CC} = 1.324$ A, $r_{CF} = 1.337$ A, $r_{CH} = 1.080$ A, $<FCC = 122°9'$, and $<HCC = 121°16'$. Rotational constants for $v_5 = 1$ were also determined. A dipole moment of 2.42 D is calculated from the Stark effect. Comparison with previously existing data for ethylene, vinyl fluoride, and vinylidene fluoride shows that there is a shortening of both the CF and the CC bonds with increasing fluorine substitution.

3539 A SPECIAL STARK-EFFECT OF A K-DOUBLET IN THE MICROWAVE SPECTRUM OF METHANOL.
H.Dreizler and H.D.Rudolph.
Z. Naturforsch (Germany), Vol. 15a, No. 11, 1013-14 (Nov., 1960). In German.

The Stark-effect of a K-doublet previously reported (Abstr. 9807 of 1960) is described in detail. The transitions are: $J = 5 \rightarrow 4$; $K = 2 \rightarrow 3$; $= 2 \rightarrow 1$; $n = 0 \rightarrow 0$. The K = 2 level for J = 5 is appreciably split, but the K = 3 level for J = 4 is practically degenerate; hence the doublet separation is the splitting of the K = 2 level. The degenerate level has first-order Stark effect, while the split level has a second-order effect at low field strengths; when the field reaches 1 e.s.u., the Stark splitting is comparable with the K-splitting and an effect intermediate between first and second

order is clearly detectable. The theory is treated for a nearly symmetric top with hindered internal rotation, following Burkhard and Dennison (Abstr. 445 of 1952) and Ivash and Dennison (Abstr. 259 of 1954). The doublet splitting is predicted as 72.2 Mc/s, as the difference of two larger numbers. This agrees satisfactorily with the 79.6 Mc/s observed. Expressions for the Stark displacements of the two lines are given, and the coefficients of the first- and second-order terms in field strength are determined and compared with theoretical values. Good agreement is obtained.
J.Sheridan

3540 INFRARED AND RAMAN SPECTRA OF FLUORINATED ETHANES. XIII. 1,2-DIFLUOROETHANE.
P.Klaboe and J.R.Nielsen.
J. chem. Phys. (USA), Vol. 33, No. 6, 1764-74 (Dec., 1960).

For Pt XII , see Abstr. 5038 of 1960. The infrared absorption spectra of CH_2F-CH_2F in the gaseous, liquid, and solid states were obtained with a double-pass spectrometer equipped with CsBr, NaCl, and LiF prisms. While the gas was studied in the spectral range from 6000 to 300 cm^{-1}, the liquid was examined from 6000 to 650 cm^{-1} and the solid from 3500 to 350 cm^{-1}. In addition, the infrared spectrum of the gas was recorded at five different temperatures between 25°C and 180°C, and some of the absorption bands were studied in solution in solvents of different polarities. The Raman spectrum of the liquid at −25°C and 35° C was photographed with a 3-prism glass spectrograph and polarization measurements made. In all three states of aggregation the compound exists as a mixture of rotational isomers. The two isomeric forms (trans and gauche) are about equally stable in the gas, while the gauche configuration is more stable in the liquid state. Tentative assignments have been made of all fundamentals except the lowest fundamental of the trans isomer.

3541 INFRARED SPECTRA AND STRUCTURE OF THE ISOMERS OF N_2F_2. R.H Sanborn.
J. chem. Phys. (USA), Vol. 33, No. 6, 1855-60 (Dec., 1960).

The isomers of N_2F_2 have been characterized in the past by their reactivity towards mercury. Investigation of the infrared spectra showed that inactive N_2F_2 is trans-1,3-difluorodiazine and may be identified by the single strong band centred at 989 cm^{-1}, with PQR structure. Active N_2F_2 resembles 1,1-difluorodiazine instead of a cis-isomer. This conclusion was reached by considering the mass spectrum, the chemical reactivity, and both the position of the infrared bands and their shapes. 1,1-difluorodiazine may be identified by strong bands at 1524 (PR), 952 (PQR), 896 (PR), and 737 (PQR) cm^{-1}, respectively. Normal coordinate analyses using the Wilson FG-matrix method were performed on both isomers.

3542 VIBRATIONAL SPECTRA OF ORTHORHOMBIC METABORIC ACID. J.L.Parsons.
J. chem. Phys. (USA), Vol. 33, No. 6, 1860-6 (Dec., 1960).

Infrared absorption spectra were obtained in the 430 to 4000 cm^{-1} region for $B_3O_3(OH)_3$, $B_3{}^{10}O_3(OH)_3$, and $B_3O_3(OD)_3$, as polycrystalline mulls and, in the case of $B_3O_3(OH)_3$, as a single crystal section. A partial Raman spectrum was obtained for $B_3O_3(OH)_3$ in the polycrystalline form. The spectral data are interpreted in terms of the vibrations of the $B_3O_3(O^-)_3$ unit, with the D_{3h} symmetry of the unit perturbed by the crystal's potential field, plus the motions of the hydrogen atoms. The latter are regarded as those of an infinite chain which has a factor group isomorphic with the point group D_{2h}.

3543 ABSORPTION SPECTRUM AND MAGNETIC PROPERTIES OF OSMIUM HEXAFLUORIDE.
J.C.Eisenstein.
J. chem. Phys. (USA), Vol. 34, No. 1, 310-18 (Jan., 1961).

It is assumed that two 5d electrons, which move in a ligand field of octahedral symmetry, are responsible for the magnetic and optical properties of the molecule. The calculated positions of the energy levels depend on the strength of the ligand field, the Coulomb integrals and the spin-orbit coupling constant. These quantities are treated as parameters. If they are given appropriate values, excellent agreement with observed energy level positions is obtained. The calculated susceptibility is also in good agreement with experimental values. In order to fit the magnetic data it is necessary to assume that the orbital reduction factor is approximately 0.7.

3544 INDUCED ABSORPTION OF INFRARED RADIATION BY MOLECULES. V.N.Filimonov.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 4, 565-90 (Dec., 1959). In Russian.

A comprehensive review of the experimental and theoretical work in the field of infrared absorption induced by pressure, constant electric fields, interaction of molecules with one another, or with surfaces in adsorption, and of infrared absorption associated with simultaneous vibrational transitions in molecules. Detailed discussion is given of the selection rules obeyed in such induced transitions, the structure of the absorption bands and calculation of their intensities. [English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 6, 894-911 (June, 1960)].
R.C.Seymour

3545 THE ISOTOPIC EFFECT IN THE SINGLET BANDS OF THE BF MOLECULE. A.A.Mal'tsev.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 428-31 (Oct., 1960). In Russian.

The emission spectra of natural and B^{10}-enriched (92%) boron trifluoride were recorded in the 1300-2090 A region. Studies of these spectra yielded information on the singlet bands of BF. A new system of BF bands was detected; it was due to the $E^1\Sigma^+-X^1\Sigma^+$ transition. More accurate values of the vibrational constants of the $D^1\Pi$ state were determined. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 225-6 (Oct., 1960)].
A.Tybulewicz

3546 THE EMISSION SPECTRUM OF THE CCl RADICAL. R.D.Gordon and G.W.King.
Canad. J. Phys., Vol. 39, No. 2, 252-62 (Feb., 1961).

A rotational analysis of the 2780 A emission band obtained in a microwave discharge through CCl vapour and photographed on a 20 ft grating spectrograph shows that a $\Delta^2_1(b) \rightarrow \Pi^2_r(a)$ transition of a the CCl radical is responsible, not $^2\Sigma \rightarrow {}^2\Pi(a)$ as reported by previous workers. Molecular constants are given for the combining states, as well as a vibrational analysis that identifies the 2780 A band as the (0-0) band.

3547 ULTRAVIOLET SPECTRUM OF THE Li_2 MOLECULE. R.Velasco.
An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 56, No. 7-8, 175-90 (July-Aug., 1960). In Spanish.

The rotational analysis is given of nine bands assigned to a transition $C^1\Pi_u \leftarrow X^1\Sigma^+_g$. The constants, which are in agreement with those determined in a recent analysis (Abstr. 17765 of 1960), are as follows: state $C^1\Pi_u$: $T_e = 30\,550.3$ cm^{-1}; $G_V = 238.24\ u - 3.37\ u^2 + 0.06\ u^3$; $B_V = 0.5068 - 0.0086\ u$; where $u = v + \frac{1}{2}$. The ionization potential of Li_2 is estimated to be 4.96 eV (perhaps ±0.1 eV).
R.F.Barrow

3548 VACUUM ULTRAVIOLET ABSORPTION SPECTRUM OF PHOSGENE. S.R.La Paglia and A.B.F.Duncan.
J. chem. Phys. (USA), Vol. 34, No. 1, 125-8 (Jan., 1961).

The spectrum of phosgene was investigated, for the first time, over the region 2000-600 A with a dispersion of about 4.15 A/mm. A number of resolved transitions were found, some with vibrational structure. The vibrational structure was in each case interpreted as a progression in a totally symmetrical frequency. A tentative interpretation of the electronic transitions is given.

A RELATIONSHIP BETWEEN ELECTRON–VIBRATIONAL ABSORPTION AND LUMINESCENCE BANDS. See Abstr. 2453

3549 STUDY OF THE ELECTRON-MOLECULE INTERACTION: ELECTRONIC TRANSITIONS INDUCED BY BOMBARDMENT. J.C.Lorquet.
J. Chim. phys. (France), Vol. 57, No. 11-12. 1078-84 (Nov.-Dec., 1960). In French.

The probability of transitions from the ground state of a molecule to an excited level of the molecular ion is related to the energy of an incident electron beam and the ionization potential. The empirical relation is in agreement with experimental results. The total ionization cross-section is calculated with less satisfactory results, but it has been possible to predict the salient features of the mass spectra of a number of small molecules.
E.R.Wooding

3550 DISTRIBUTION OF INTENSITIES OF THE α-SYSTEM BANDS OF THE TiO MOLECULE. F.S.Ortenberg.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 147-50 (Aug., 1960). In Russian.

A semi-empirical method was used to find the dependence of the electronic moment of transitions on internuclear separations (1.58 A < r < 1.72 A) for the α-band system of TiO. More accurate values of the relative probabilities of the v'—v'' transition were found for this band system. Formulae were deduced for the calculation of gas temperatures from the relative intensities of α-bands. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 80-81 (Aug., 1960)].
A.Tybulewicz

3551 SINGLE-CENTRE EXPANSIONS FOR THE HYDROGEN MOLECULAR ION.
M.Cohen and C.A.Coulson. Appendix by L.Fox.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 96-106 (Jan., 1961).

Discussion of an expansion in which the radial functions were determined numerically shows that a three-term expansion (s,d and g) gives sufficient accuracy for most calculations on the ground state, except in the region of the nuclei. The method used for numerical solution of four coupled eigenvalue equations uses Newton's method in the joining of the forward and backward integrations. J.Hawgood

3552 FRANCK–CONDON FACTORS OF THE SCHUMANN–RUNGE BAND SYSTEM OF THE OXYGEN MOLECULE.
I.T.Yakubov.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 409-12 (Sept., 1960). In Russian.

An approximate method of calculating Franck–Condon factors for large values of (v' + v'') developed by the author and Biberman (Abstr. 15749 of 1960), is applied to the Schumann–Runge band system of O_2. The results are tabulated for v' = 0-5 and v'' = 6-20; they agree well with the values obtained by Losev (1958) who used a computer to solve exactly the Schrödinger equation. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 212-13 (Sept., 1960)]. A.Tybulewicz

3553 CALCULATION OF THE RELATIVE TRANSITION PROBABILITIES FOR SOME BAND SYSTEMS OF GROUP II OXIDES AND HYDRIDES. F.S.Ortenberg.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 151-5 (Aug., 1960). In Russian.

Bates' method and simplified Morse potential were used to calculate relative transition probabilities for the following band systems: $B^1\Sigma^+ \rightarrow X^1\Sigma^+$ of BeO, $B^1\Sigma \rightarrow X^1\Sigma$ of MgO, $A^1\Sigma \rightarrow X^1\Sigma$ of BaO, $A^2\Pi \rightarrow X^2\Sigma$ of MgH, $A^2\Pi \rightarrow X^2\Sigma$ of CaH. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 82-84 (Aug., 1960)]. A.Tybulewicz

MOLECULAR LUMINESCENCE AND LUMINESCENCE ANALYSIS. U.S.S.R. CONFERENCE. See Abstr. 2450

EFFECTS OF SHOCK WAVES ON ATMOSPHERIC OXYGEN. See Abstr. 2778

3554 "IONIC RADII," SPIN-ORBIT COUPLING AND THE GEOMETRICAL STABILITY OF INORGANIC COMPLEXES. A.D.Liehr.
Bell Syst. tech. J. (USA), Vol. 39, No. 6, 1617-26 (Nov., 1960).

The van Santen and van Wieringen theory (1952) of "ionic radii" is briefly reviewed and extended to include spin–orbit influences. It is noted that, although for the most part spin–orbit forces have little effect upon stereochemical predictions made for the first transition series, noteworthy exceptions to this rule occur for octahedral complexes of Co^{2+} and tetrahedral complexes of Ni^{2+} and Cu^{2+}. Indeed, it is found that spin–orbit coercions render the ground state of these molecules Jahn–Teller resistant. Diagrams are displayed and tables compiled to illustrate the variation of ionic radii with atomic number for the second and third transition series. Paths for future theoretical research are indicated.

3555 THE INTERACTION OF ELECTRONIC AND VIBRATIONAL MOTIONS IN COMPLEX MOLECULES.
M.A.El'yashevich.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 1, 156-60 (May, 1960). In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 3, No. 3, 440-3 (Nov.-Dec., 1960).

The importance of carrying out systematic studies of the interactions of electronic and vibrational motion in molecules as an aid to the development of the theory of luminescence and absorption is stressed. A qualitative treatment indicates that there are no grounds for expecting large electronic–vibration interactions in complex molecules, but that radiationless transitions may become highly probably if interactions of electronic and vibrational motion occur due to failure of the adiabatic approximation. [See Kronig, Band Spectra and Molecular Structure, New York: Macmillan, (1930)]. W.J.Orville-Thomas

3556 ON THE FLUORINE MOLECULE. I. THE PILOT CALCULATION. K.Hijikata.
J. chem. Phys.(USA), Vol. 34, No. 1, 221-31 (Jan., 1961).

The energy levels of the fluorine molecules F_2 are calculated by ASMO method. First and second quantum orbitals and configurations therefrom are all taken into account, resulting in D_o = 1.99 eV and R_e = 1.41 A. Vertical excitation energies of $^1\Sigma_g^+ - {}^1\Pi_u$ and $^1\Sigma_g^+ - {}^3\Pi_g$ are 5.21 eV and 3.93 eV, respectively. The importance of the configurations and of the inner-shell electrons to the ground state is discussed. Finally, the ionicities of the states are evaluated.

3557 ON THE FLUORINE MOLECULE. II. ENERGY LEVELS OF F_2 AND F_2^+. K.Hijikata.
J. chem. Phys. (USA), Vol. 34, No. 1, 231-9 (Jan., 1961).

The same ASMO treatment as in Pt I (preceding abstract) is applied to the fluorine molecule with several pairs of effective nuclear charges, and the best value of the effective nuclear charge is determined for each state. The ground state $^1\Sigma_g^+$ has D_e = 2.02 eV, R_e = 1.437 A and the effective nuclear charge 2.58. It is found that the explanation for the effective nuclear charge of each state from the "atomic point of view" is difficult. The vertical excitation energies $^1\Sigma_g^+ - {}^1\Pi_u$, $^1\Sigma_g^+ - {}^3\Pi_u$, and $^1\Sigma_g^+ - {}^1\Pi_g$ are calculated to be 4.49, 3.73, and 6.50 eV, respectively. The lower energy levels of the molecular ion F_2^+ are also calculated, showing that the ground state is $^2\Pi_g$, that two more states appear to have potential minima, and that the higher energy levels of F_2 calculated by ASMO are almost meaningless except $^1\Sigma_u^+$. The energy level of this ionic state $^1\Sigma_u^+$ at R = 1.625 A is 10.8 eV above the minimum of $^1\Sigma_g^+$. The energy diagram summarizing the calculations is shown. The discrepancy is indicated between the experimental and the theoretical ionization potentials.

3558 ON THE CONNECTION BETWEEN THE NUMBER OF π-ELECTRONS AND THE CHARACTER OF THE MAGNETIC SUSCEPTIBILITY OF A CLASS OF AROMATIC MOLECULES. T.K.Rebane.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 568-70 (Nov. 21, 1960). In Russian.

Starts with the expression

$$\chi_\pi = -\sum_p \nu_p \left(\frac{\partial^2 \epsilon_p}{\partial H^2}\right)_{H=0}$$

for the contribution of the π-electronic current to the mass susceptibility of aromatic molecules. Here ν_p = 0, 1 or 2, is the number of π-electrons in the p-th molecular energy level ϵ_p and H is the magnetic field strength. This is applied first to monocyclic aromatic compounds. An abbreviated account of the mathematics leads to values of ϵ_p and χ_π. Since χ_π proves to be negative, it has a diamagnetic character. In polycyclic aromatic molecules χ_π may be either positive or negative. The author gives a qualitative theory of this, based on perturbation theory. A table gives calculated values of χ_π for twelve aromatic compounds, and the number of π-electrons in each case. [English translation in: Soviet Physics–Doklady (USA)]. N.Davy

3559 MOLECULAR ORBITAL TREATMENT OF HYDROGEN WITH CENTRAL POTENTIALS AND MODIFIED BOUNDARY CONDITIONS. J.M.Peek and E.N.Lassettre.
J. chem. Phys. (USA), Vol. 33, No. 6, 1803-7 (Dec., 1960).

A model is proposed for a homonuclear diatomic molecule in which each electron is treated as moving in the field which would prevail for an isolated atom but with boundary conditions which require that either the one electron eigenfunction, or its normal derivative, vanishes along a plane perpendicular to the line of centres and passing through the midpoint. The model is tested by applying it to molecular hydrogen. The assumed potential is compared to that computed from a Heitler–London function, using a suggestion of Slater, and the energy of the ground state of hydrogen is computed as a function of internuclear distance. Employing the model throughout (i.e. without averaging the exact Hamiltonian) a dissociation energy of 5.65 eV is obtained and an equilibrium internuclear distance of 1.7 a.u. is predicted.

3560 METHOD OF ALTERNANT ORBITALS FOR ALLYL. H.H.Dearman and R.Lefebvre.
J. chem. Phys. (USA), Vol. 34, No. 1, 72-3 (Jan., 1961).

The π-electron correlation energy and ground-state wavefunction for allyl are calculated by the method of alternant orbitals.

This method accounts for 98.8% of the correlation energy given by the configuration interaction treatment. The atomic orbital spin density matrix obtained with this approximation is also included.

3561 PARAMAGNETISM OF URANYL ION. EFFECT OF 6d ORBITALS AND Pi BONDING. R.L.Belford.
J. chem. Phys. (USA), Vol. 34, No. 1, 318-21 (Jan., 1961).

Second-order perturbation calculations of the paramagnetism of OUO^{++} ion are carried out. The contribution from π bonds may be considerable. Although a bonding scheme utilizing only the 6d and 7s orbitals of U could account for experimental values, some involvement of 5f orbitals is suggested. There is no clear-cut evidence for strong involvement of 5f orbitals in bonds.

3562 THE ANALYSIS OF MOLECULAR WAVE FUNCTIONS BY NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. M.Karplus.
J. phys. Chem. (USA), Vol. 64, No. 12, 1793-8 (Dec., 1960).

A valence-bond formulation is presented for the relationship between molecular wave-functions and the electron-coupled nuclear spin interactions observed by nuclear magnetic resonance spectroscopy. For non-bonded atoms, the magnitude of the coupling is shown to depend on the deviations from perfect pairing in the wave-function. This result makes it possible to use the measured coupling constants in testing models for hyperconjugation. An application to the second-order hyperconjugation in ethane is given. For directly-bonded atoms, the coupling constant depends on parameters, such as orbital hybridization and bond polarization, in localized electron-pair functions. Use of this dependence is made to determine the bond polarization in several tetrahedral molecules.

3563 SIMPLE PERTURBATION CALCULATIONS ON THE ENERGY LEVELS OF π-ELECTRON SYSTEMS. II. M.Das and R.Bhattacharya.
J. Chim. phys. (France), Vol. 57, No. 11-12, 947-51 (Nov.-Dec., 1960). In French.

The method used in Part I [Ibid., Vol. 55, 396(1958)] for calculating the energy levels of polynuclear aromatic hydrocarbon molecules is extended to asymmetric and heteroatomic molecules. All rings are supposed initially opened, and the corresponding open-chain hydrocarbon taken as the zero-order solution; the closing of the rings, and the introduction of heteroatoms, are then regarded as perturbations. It is found that a linear relation holds between the energies so obtained and those found by the molecular orbital method, so that the latter can be reasonably well predicted from the former. This process works better for asymmetric than for symmetric molecules. J.Hawgood

3564 BONDING IN ICOSAHEDRAL COMPLEXES. J.H.Macek and G.H.Duffey.
J. chem. Phys. (USA), Vol. 34, No. 1, 288-90 (Jan., 1961).

Results of a group theoretical investigation of icosahedral AB_{12} are presented. These are used in setting up twelve equivalent, orthogonal bond orbitals. Each of the orbitals exhibits a Pauling strength of 3.921. Crystal-field splitting of valence levels of A is also discussed.

3565 NUCLEAR SPIN CONSERVATION IN ORTHO–PARA HYDROGEN CONVERSION. D.Britton and Z.Z.Hugus, Jr.
J. chem. Phys. (USA), Vol. 33, No. 6, 1830-2 (Dec., 1960).

The details of statistics of the nuclear spin states in the ortho–para hydrogen conversion by hydrogen atoms are considered. It is shown that the observed rate of conversion is 5/6 the rate of formation of the transition state if H_3 is linear. The factor is 8/9 if H_3 is an equilateral triangle.

3566 ELECTRON SPIN RESONANCE AND OPTICAL ABSORPTION OF $K_3[Cr(CN)_5NO]\cdot H_2O$. I.Bernal and S.E.Harrison.
J. chem. Phys. (USA), Vol. 34, No. 1, 102-6 (Jan., 1961).

Electron spin resonance of a water solution and of the pure powder of $K_3[Cr(CN)_5NO]\cdot H_2O$ reveal a single sharp resonance line at room temperature. The water solution resonance gives a Cr^{53} hyperfine structure which is further split by a "superhyperfine" structure due to the nitrogen in the NO ligand. From the electron spin resonance the Cr^{1+} ion appears to be in a spin quenched ($d\epsilon^5$) orbital singlet ground state. The optical absorption data allows the determination of the splittings of the d levels in concordance with the e.s.r. spectrum.

3567 NUCLEAR MAGNETIC RESONANCE SPECTRA OF THE ABX_3 TYPE: FIELD DEPENDENCE AND RELATIVE SIGNS OF SPIN–SPIN COUPLING CONSTANTS. V.J.Kowalewski and D.G.deKowalewski.
J. chem. Phys. (USA), Vol. 33, No. 6, 1794-8 (Dec., 1960).

The ABX_3 spin system is studied as a function of applied magnetic field. A method for the determination of the relative signs of J_{AX} and J_{BX}, together with the relative chemical shifts and coupling constants is described. The results are applied to the cis crotonic acid, the trans crotonic acid, its methyl ester and N-methylformamide. In the latter case it is shown that the relative chemical shift of the A and B protons can be estimated from the field behaviour of the X_3 group of lines.

3568 PROTON SPIN COUPLING BY Pi ELECTRONS. M.Karplus.
J. chem. Phys. (USA), Vol. 33, No. 6, 1842-9 (Dec., 1960).

A theoretical formulation is developed for the π-electron contribution, $A_{HH'}(\pi)$, to the spin coupling between pairs of protons in hydrocarbon molecules. By means of the correspondence between the σ–π interaction in unsaturated molecules and related free radicals, the proton spin coupling is expressed in terms of hyperfine constants and triplet state energies. With known values for these quantities, $A_{HH'}(\pi)$ is found to be in agreement with experimental measurements available for molecules in which the π electrons are expected to dominate the coupling. Of particular interest are the large couplings (1.3–8 c/s) calculated for certain systems with protons separated by three or four carbon atoms. Also absolute signs are predicted by the theory, with $A_{HH'}(\pi)$ equal to -6.7 c/s for allene and $+7.8$ c/s for butatriene.

3569 ANALYSIS OF THE NUCLEAR MAGNETIC RESONANCE SPECTRA OF $A_3B_2X_2$-TYPE GROUPS. V.I.Glazkov.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 417-18 (Sept., 1960). In Russian.

Deals with analysis of the spectra of $A_3B_2X_2$–type groups, such as $(CH_3CH_2CH_2)_2O$ or $CH_3CH_2CH_2Br$. For these two molecules chemical shifts and spin–spin interaction constants were obtained. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 217 (Sept., 1960)]. A.Tybulewicz

3570 SPIN–SPIN INTERACTIONS IN NUCLEAR MAGNETIC RESONANCE. CONTACT CONTRIBUTION. S.Alexander.
J. chem. Phys. (USA), Vol. 34, No. 1, 106-17 (Jan., 1961).

A method for calculating the contact contribution to spin–spin interactions between nuclei in nonaromatic molecules is described. The method is based on the valence bond model. The equivalent Hamiltonian of the Dirac vector model is used for a perturbation calculation in a representation where the total spin of the two electrons in each bond in the molecule is a good quantum number. The Ramsey–Purcell contact term in the interaction is calculated by a double perturbation method where only terms linear in the electron–nuclear interactions are considered but the perturbation is carried to higher order in the exchange integrals. In this way the interaction constants can be obtained explicitly in terms of the exchange integrals, and the calculation of the valence bond wave-functions is avoided. It is then possible to see how the signs and magnitudes of the interaction constants depend on these integrals and what the dominant interaction mechanisms are. The perturbation series is evaluated explicitly with the electron nuclear contact interaction and the results are compared with the results of a similar calculation based on Ramsey's closure formula. In this way the objections against the closure procedure can be avoided. It is shown that Ramsey's formula can be used when different average energy separations are used for terms of different order in the expansion. The results of Ramsey for H_2 and of Karplus et al. for hydrogen atoms separated by two and three bonds and the justification of the method of calculation used by them are discussed in detail. It is found that only perturbation terms of one type are important in each of the cases discussed by these authors and therefore their procedure can be justified. The results previously obtained by the author for spin–spin interactions in the allyl group are also discussed.

3571 EFFECT OF DISSOLVED OXYGEN ON THE SPIN–LATTICE RELAXATION TIME OF FREE RADICALS IN PETROLEUM OILS. A.J.Saraceno and N.D.Coggeshall.
J. chem. Phys. (USA), Vol. 34, No. 1, 260-3 (Jan., 1961).

Electron paramagnetic resonance studies of free radicals in petroleum oils reveal that the presence of dissolved oxygen

significantly affects the free radical spin-lattice relaxation time, T_1. Changes in T_1 can occur upon: (a) dilution with solvents, (b) exposure to light, (c) bubbling with oxygen, and (d) stripping of dissolved oxygen. In this investigation it is shown that these changes all result from the influence of dissolved oxygen. Dilution with ordinary solvents results in a decrease of T_1. If the solvent is first stripped of dissolved oxygen, there will be no changes in T_1. The effect is reversible, i.e., the value of T_1 for free radicals in a petroleum oil may be arbitrarily decreased or increased by adding or removing dissolved oxygen, respectively. It was observed that free radicals in oil, or in oil in solution, experienced an increase in spin-lattice relaxation time when allowed to remain sealed in a quartz tube. This change was traced to the effect of light and appears to occur for wavelengths of the order of 5400 A and lower. It is concluded that this phenomenon is due to the photochemical takeup of dissolved oxygen whose presence decreases T_1. This is based on the fact that T_1 may be lowered to its original value merely by adding molecular oxygen to the petroleum oil. Depending upon the degree of saturation being effected, changes in T_1 will be reflected as changes in "apparent" free radical content. The true free radical content was unchanged by the processes studied.

3572 THE ABSORPTION SPECTRUM AND DISSOCIATION ENERGY OF SH. J.W.C.Johns and D.A.Ramsay.
Canad. J. Phys., Vol. 39, No. 1, 210-17 (Jan., 1961).

The (2,0) bands of the $A^2\Sigma^+ - X^2\Pi$ system of SH and SD were photographed for the first time. More accurate values for the vibrational constants of the $A^2\Sigma^+$ state were obtained. The dissociation energy of SH in the excited state is $D_0' = 8020 \pm 1000$ cm^{-1} from which it is possible to deduce that the ground state dissociation energy $D_0''(SH)$ is 28 480 ± 1000 cm^{-1} (81.4 ± 2.9 kcal/mole, 3.53 ± 0.12 eV).

3573 MASS SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGIES OF THE MOLECULES AgAu, AgCu, AND AuCu.
M.Ackerman, F.E.Stafford and J.Drowart.
J. chem. Phys. (USA), Vol. 33, No. 6, 1784-9 (Dec., 1960).

The vapours issuing from mullite and graphite Knudsen cells containing pure metals and alloys of the triad Cu–Ag–Au were analysed mass spectrometrically. From the experimental ratios of diatomic to monoatomic species and the vapour pressures of the elements, the following dissociation energies are obtained:

$D_0^0(Cu_2) = 45.5 \pm 2.2$ kcal	$D_0^0(AgAu) = 47.6 \pm 2.2$ kcal
$D_0^0(Ag_2) = 37.6 \pm 2.2$ kcal	$D_0^0(AgCu) = 40.7 \pm 2.2$ kcal
$D_0^0(Au_2) = 51.5 \pm 2.2$ kcal	$D_0^0(AuCu) = 54.5 \pm 2.2$ kcal

These are based on $\Delta H_{298}^{vap} = 81.1$, 68.4, and 87.5 kcal/g atom for Cu, Ag, and Au where D_0^0 of AgCu depends on the value for Cu, and D_0^0 of AgAu and AuCu on Au. The uncertainties quoted do not include the uncertainty in ΔH^{vap}.

3574 RELATION BETWEEN THE PROTON HYPERFINE INTERACTION AND THE C^{13}–H^1 SPIN-SPIN COUPLING IN FREE RADICALS. R.A.Bernheim and T.P.Das.
J. chem. Phys. (USA), Vol. 33, No. 6, 1813-15 (Dec., 1960).

It is shown that the C^{13}–H^1 spin-spin coupling constant $J(C^{13}–H^1)$ and the proton hyperfine constant $Q(H^1)$ in a free radical can be considered as interdependent, and that they both can be estimated by calculating the perturbation produced in the electronic wave-functions by the magnetic moment of the proton. For a C–H fragment with an unpaired π electron on the carbon atom an approximate relation is established between $Q(H^1)$ and $J(C^{13}–H^1)$. Using the experimental value of $J(C^{13}–H^1)$ for the benzene molecule, $Q(H^1)$ is found to have a negative sign and order of magnitude agreement with experiment.

3575 DEPENDENCE OF CALCULATED AND EXPERIMENTAL PROPANE MASS SPECTRA UPON ELECTRON VOLTAGE. E.M.Eyring and A.L.Wahrhaftig.
J. chem. Phys. (USA), Vol. 34, No. 1, 23-8 (Jan., 1961).

Experimental propane mass spectra were obtained with bombarding electrons ranging in energy from 14 to 500 V. The quasi-equilibrium theory is used in calculating the same spectra. The grossly simplified version of the statistical theory that satisfactorily predicts the 70 V mass spectrum is inadequate at low voltages, but if half the theoretical number of oscillators are assumed to be effective in the parent-ion and activation energies that bear no simple relation to experimental appearance potentials are employed, a semiquantitative fit of the experimental data is obtained. The description of the decomposition reaction of a molecule-ion in terms of a collection of harmonic oscillators is clearly unsatisfactory. However, the more general form of the quasi-equilibrium theory, in which it is assumed only that the reaction coordinate is separable, does appear to be applicable.

3576 INTRAMOLECULAR ENERGY TRANSFER BETWEEN TRIPLET LEVELS. V.L.Ermolaev and A.N.Terenin.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 1, 137-41 (May, 1960). In Russian.

The luminescence of the carbonyl derivatives of biphenyl and naphthalene is ascribed to intramolecular transfer of excitation energy. This explains the absence in the spectra of a fluorescence spectrum adjacent to the first absorption maximum, and also the presence of a phosphorescence spectrum characteristic of the biphenyl or naphthyl group. The characteristic C=O frequency of 1600-1700 cm^{-1} is also absent. The 1400 cm^{-1} frequency for the aromatic rings is present in both series of derivatives. [English translation in: Soviet Physics–Uspekhi (USA), Vol. 3, No. 3, 423-6 (Nov.-Dec., 1960)]. T.E.Peacock

EFFECT OF MOLECULAR ASSOCIATION ON THE VELOCITY OF SOUND IN LIQUIDS. See Abstr. 2755

3577 PROBLEMS IN THE THEORETICAL PHYSICS OF POLYMERS. M.V.Vol'kenshtein.
Uspekhi. fiz. Nauk (USSR), Vol. 67, No. 1, 131-61 (Jan., 1959). In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 2(67), No. 1, 59-81 (Jan.-Feb., 1959).

The characteristics of macromolecules are outlined, and the fundamental problems of the theoretical physics of polymers are defined for isolated macromolecules in solution and for bulk polymers. The present state of the theory is reviewed with particular reference to the configurational statistics of polymeric chains, the physics of the elasticity of rubber, the vitrification of low molecular weight liquids and polymers, and the crystalline state of polymers. 130 references. B.J.Wilson

3578 INTRAMOLECULAR INTERACTIONS IN POLYMER CHAINS. O.B.Ptitsyn.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 3, 371-417 (Nov., 1959). In Russian. English translation in: Soviet Physics–Uspekhi (USA), Vol. 2, No. 6, 797-830 (June, 1960).

A review of the work of Russian and Western scientists in the field of the physics of polymer solutions. Long-range interactions are treated fully but short-range interactions are discussed only briefly. It is shown that modern theories require that both long-range and short-range interactions should be taken into account in order to explain quantitatively the properties of macromolecules in solution. If the molecular weight, the dimensions of the molecule of a given polymer in a given solvent and the dimensions in an ideal solvent are known it is now possible to predict: (1) the second virial coefficient, (2) the form of the curve of angular disymmetry of light-scattering, (3) the intrinsic viscosity and (4) the translational frictional constant with an accuracy comparable with experimental errors. A detailed, critical account is given of the concept that the volume effects may be accounted for by assuming that the coiled molecules expand uniformly from their ideal configuration to their actual configuration. The author deals exclusively with linear polymers which do not have free charges nor hydrogen-bonding groups but it is emphasized that the development of a quantitative theory of the properties of molecules of polyelectrolytes and hydrogen-bonded polymers is one of the most urgent problems in this field. 233 references. J.Iball

3579 MOLECULAR STRUCTURE IN CRYSTAL AGGREGATES OF LINEAR POLYETHYLENE. R.D.Burbank.
Bell Syst. tech. J. (USA), Vol. 39, No. 6, 1627-63 (Nov., 1960).

Crystal aggregates of linear polyethylene were studied in the electron microscope. Twinning was observed to occur across (530) planes, and possibly across (120) planes. Crystal morphologies were observed which exhibit (530) and (540) faces. Electron interference effects were observed which gave rise to contrast lines and figures which frequently are parallel to crystallographic directions. These observations, and those of others, are interpreted in terms of recently proposed ideas on molecular chain folding. It is suggested that chain folds may lie in a variety of fold planes or fold surfaces which are normal, or nearly normal, to the crystal lamellae. It is shown that a continuity of fold structure is necessary and

possible across a wide variety of boundaries delineating regions of different fold structure. It is also shown that these structural concepts are compatible with recently proposed ideas on the growth of lamellar polymer crystals and can suggest new details of the growth process.

3580 DIPOLE MOMENT OF POLAR POLYMERS IN RELATION TO THEIR CONFIGURATION. I.Taniguchi.
Doshisha Engng Rev. (Japan), Vol. 10, No. 3-4, 116-28 (Dec., 1959). In Japanese.

The dipole moments of long-chain polar molecules are given, considering the structural details of their hindered rotation. The dipole moment of polymonochlorotrifluoroethylene was measured, and the theory applied to it. The average value of the cosine of the internal rotational angle is about 0.68, which shows that the degree of hindrance of this substance is larger than that of polyvinylchloride as measured and discussed by Fuoss and Kirkwood (1941).

3581 VAPOR PRESSURES AND RELATED THERMODYNAMIC PROPERTIES OF THE ISOTOPIC NITRIC OXIDE MOLECULES. J.Bigeleisen.
J. chem. Phys. (USA), Vol. 33, No. 6, 1775-7 (Dec., 1960).

The large differences in thermodynamic properties of the isotopic NO molecules are interpreted in terms of the known structure of interacting dimers. It is shown that structural considerations alone suffice to calculate the relative O^{18} to N^{15} isotope effects on vapour pressure, heats of vaporization, and triple points. The calculated relative quantities are in excellent agreement with experiment. The properties of $N^{15}O^{18}$ are shown to be completely determined by those of $N^{14}O^{16}$, $N^{15}O^{16}$, and $N^{14}O^{18}$. The absolute value of the vapour pressure ratio of $N^{14}O^{16}/N^{15}O^{16}$ is calculated from spectral data in good agreement with experiment.

SOLID-STATE PHYSICS

3582 SOME PROPERTIES OF ALKALI HALIDE CRYSTALS. E.A.Braun.
Amer. J. Phys., Vol. 29, No. 3, 182-6 (March, 1961).

The cohesive energy of alkali halide crystals can be approximated by treating it as arising from purely polar interactions. An attractive Coulomb potential and a repulsive overlap potential are the only terms that need to be considered. The phenomenon of coloration of alkali halides is described with particular emphasis on the mechanisms involved. As an example of luminescence, the luminescent process in Tl activated alkali halides is discussed.

3583 ON A NON-LINEAR DIFFERENTIAL EQUATION FOR THE ZERO-POINT ENERGIES OF THE RARE GAS SOLIDS. M.E.Fisher and I.J.Zucker.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 107-14 (Jan., 1961).

Analysis of the mathematical properties of the equation, due to Domb (1952), solved approximately by Dugdale and MacDonald (Abstr. 9216 of 1954), shows that the iteration scheme used in the latter paper is divergent and the approximate solutions found differ greatly from the exact solutions. Further, the equation has no physically meaningful solutions at all, and so cannot be interpreted as determining the Debye temperature in terms of the interatomic potential. J.Hawgood

3584 THE INFLUENCE OF FIELD EMISSION OF ELECTRONS ON THE DISTRIBUTION OF STRONG FIELDS IN SOLIDS. É.I.Adirovich.
Izv. Akad. Nauk. SSSR, Ser. fiz., Vol. 24, No. 1, 49-57; Disc. 91-3 (1960). In Russian.

"1958 Moscow Dielectrics Conference" (See Abstr. 16003 of 1960). Briefly describes a method proposed by Bër (Abstr. 18088 of 1960) of determining the distribution of electric fields in solids by observation of the optical absorption at different wavelengths. A theoretical analysis of the method is given for a material such as a CdS crystal. The effect of field emission of electrons on the distribution of fields is obtained in analytical form.
A.E.I.Research Laboratory

3585 NUCLEAR ORIENTATION IN ANTIFERROMAGNETIC SINGLE CRYSTALS.
J.M.Daniels, J.C.Giles and M.A.R.LeBlanc.
Canad. J. Phys., Vol. 39, No. 1, 53-64 (Jan., 1961).

Mn^{54} and Co^{60} were successfully oriented in five antiferromagnetic single crystals ($MnCl_2.4H_2O$, $MnBr_2.4H_2O$, $CoCl_2.6H_2O$, $Co(NH_4)_2(SO_4)_2.6H_2O$, and $MnSiF_6.6H_2O$) and the orientation was detected by the anisotropy of the emitted γ-rays. Only in the case of Co^{60} in $MnBr_2.4H_2O$ was no γ-ray anisotropy seen. It is concluded that antiferromagnetism can be used as a means of producing nuclear orientation. Attempts to orient Br^{82} and I^{131} in the manganese halides by superexchange were unsuccessful.

3586 INFLUENCE OF MAGNETIC INTERACTION ON NUCLEAR ORIENTATION OF COBALT-60 IN RARE-EARTH DOUBLE NITRATES.
M.W.Levi, R.C.Sapp and J.W.Culvahouse.
Phys. Rev. (USA), Vol. 121, No. 2, 538-46 (Jan. 15, 1961).

The effect of ionic spin—spin interactions on nuclear orientation of Co^{60} in cereus zinc nitrate was investigated in single-crystal spherical samples cooled below 1°K by adiabatic demagnetization. An experimental demonstration is given that Ce—Co interaction is indeed the cause of the apparently anomalous alignment data. By hypothesizing the existence of a temperature-dependent internal magnetic field, exerted on cobalt ions by cerium dipoles, a simple but quantitatively satisfying description of the observed phenomena is obtained. In the theoretical calculations, measured values of g-factors and h.f.s. splittings of cobalt ions in the cerium salt are used. Crystal structure information is invoked only for the purpose of a symmetry argument. The effectiveness of CeZn nitrate as a paramagnetic medium for nuclear orientation experiments is pointed out.

3587 GAMMA-RAY ANISOTROPIES FROM ORIENTED Pm^{144}. D.A.Shirley, J.F.Schooley and J.O.Rasmussen.
Phys. Rev. (USA), Vol. 121, No. 2, 558-61 (Jan. 15, 1961).

Radioactive Pm^{144} was oriented at low temperatures in a single crystal of neodymium ethylsulphate. The gamma rays at 475, 615, and 695 keV were found to be anisotropic. The results confirm the decay scheme previously proposed as well as crystal field calculations for Pm^{3+} in this lattice. It is not possible to decide between spin 5 and 6 for Pm^{144}. Values were obtained for $|A|/k$ and $|\mu|$ of 0.0091°K and 1.68±0.14 n.m. for I = 5, or 0.0079°K and 1.75±0.14 n.m. for I = 6. The lowest doublet of Pm^{3+} was found to be split, presumably due to Jahn—Teller distortion.

3588 ELECTRIC FIELD GRADIENTS IN DILUTE ALLOYS OF SILVER. C.A.Giffels, G.W.Hinman and S.H.Vosko.
Phys. Rev. (USA), Vol. 121, No. 4, 1063-9 (Feb. 15, 1961).

The directional correlation of the gamma rays emitted in the decay of Cd^{111} was measured with the cadmium embedded in the cubic silver lattice in order to observe the electric field gradients produced by various solute atoms. The alloys studied contained small concentrations of cadmium, indium, tin, antimony, or germanium. The results were compared to various theories of screening and were found to be in agreement with a $\cos(2kr + \phi)/r^3$ fall-off of shielding charge, where k is the wave number at the Fermi surface. This work corroborates the results of Rowland (Abstr. 13890 of 1960) by an independent method.

CONTRIBUTION TO THE THEORY OF THE MOSSBAUER EFFECT. See Abstr. 3389

NUCLEAR ORIENTATION AND OVERHAUSER EFFECT. See Abstr. 3944

3589 DISTORTION CORRECTION TO THE SURFACE ENERGY OF THE {110} FACE OF ALKALI HALIDE CRYSTALS. G.C.Benson, E.Dempsey and P.Balk.
J. chem. Phys. (USA), Vol. 34, No. 1, 157-62 (Jan., 1961).

Formulae for the contribution of surface distortion to the surface energy of the {100} and {110} faces of the NaCl-type lattice and of the {110} face of the CsCl-type lattice are obtained by a generalization of a treatment described previously for the {100} face of the NaCl structure. Numerical values of the distortion correction to the surface energy of the {110} faces of all of the alkali halides are presented. These results are discussed in relation to the values calculated previously for the {100} face and to the limited experimental information available.

LATTICE MECHANICS

3590 SOLUTION OF THE FUNCTIONAL DIFFERENTIAL EQUATION FOR THE STATISTICAL EQUILIBRIUM OF A CRYSTAL. R.M.Lewis and J.B.Keller.
Phys. Rev. (USA), Vol. 121, No. 4, 1022-37 (Feb. 15, 1961).

The s-particle distribution functions (s = 1, 2, . . .) of classical equilibrium statistical mechanics are determined for a crystal, as power series in the temperature. They are obtained by solving Bogolyubov's functional differential equation. From the distribution functions, the thermodynamic functions of a crystal are computed as power series in the temperature. The leading terms in these series are the usual classical results which are customarily derived by assuming that the potential energy is a quadratic function of the particle displacements. The further terms, which depend upon the nonquadratic or anharmonic terms in the potential, provide corrections to the usual results, which become more important as the temperature increases. If only a few terms in the series are used, the results will be valid at temperatures low compared to some characteristic temperature of the crystal, e.g. the melting temperature. Since they are based on classical mechanics, the results are valid only at temperatures high compared to the Debye temperature. The series expansions of the distribution functions and thermodynamic functions may be viewed as the low temperature analogue of the virial expansions, which are low-density expansions. As in the case of the virial expansions, all the terms are determined explicitly in analytic form, but their actual evaluation is difficult.

3591 INTERMOLECULAR COUPLING OF VIBRATIONS IN MOLECULAR CRYSTALS: A VIBRATIONAL EXCITON APPROACH. R.M.Hexter.
J. chem. Phys. (USA), Vol. 33, No. 6, 1833-41 (Dec., 1960).

A vibrational exciton theory is developed which parallels in many ways the electronic exciton theory originally put forward by Davydov and amplified by Craig and Hobbins and by Fox and Schnepp. The kernel of the theory is the adoption, following Davydov again, of a transition-dipole–transition-dipole interaction as the potential which perturbs the isolated molecule energies and which thereby couples the motions of pairs of molecules in a crystal. As a result of the quantitative application of this theory, molecular dipole derivatives of several of the parallal modes of methyl chloride are obtained from the correlation field splittings of the corresponding fundamentals in the spectrum of solid methyl chloride. An isotope effect upon correlation field splittings is reported and is accounted for in terms of the same theory. A general method of testing the theory in terms of this isotope effect is suggested. The effect of intermolecular transition dipole coupling on intensities is derived and compared with the ratio of the dipole derivatives obtained from the correlation field splittings to those obtained from absolute intensity studies in the gas phase. The possible use of other bases for correlation field splittings is also discussed.

3592 CORRECT ENUMERATION OF VIBRATION FREQUENCIES IN THE BRILLOUIN ZONE. B.Dayal and S.P.Singh.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 777-9 (Nov., 1960).

In order to calculate the vibration frequencies by Born's method the Brillouin zone is sub-divided into a number of points. The actual number of frequencies used by other workers for the calculation of C_v is, however, different from the number of points of the zone, resulting in a non-uniform distribution of points. It is shown that this results in an incorrect value of the specific heat. As an example Hsieh's theoretical results (Abstr. 4773 of 1954) are used to recalculate the specific heat of silicon with a proper number of frequencies. The difference between these revised results and Hsieh's original calculations is found to be large.

3593 ON THE VIBRATION OF DISORDERED LINEAR LATTICE. III. J.Hori.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 475-89 (March, 1960).

For Pt II see Abstr. 11568 of 1959. The eigenfrequency spectrum of an isotopic two-component disordered lattice is calculated approximately by a method which requires only a comparatively small amount of numerical work. An argument based on perturbation theory shows formally that the spectrum of a completely random lattice is the same as that of a virtual regular lattice composed of atoms with average mass, except at the edge and outside of the band. The validity of this statement is investigated and the result is obtained that the smaller the concentration of approximately the same as that of virtual regular lattice. The spectrum is then calculated in the neighbourhood of the edge of the band where the above statement does not hold, by applying the moment-trace method only to that region. The result is that when the concentration of lighter atoms is comparable with or larger than that of heavier atoms, there is only one presumably rounded maximum at the position of the band-edge of the virtual regular lattice, whereas when the number of lighter atom becomes smaller, there appears an impurity band, its separation from the main band coming out more distinctly as the concentration of lighter atoms gets smaller. Both results are reasonable provided the spectrum is to approach that of a Poisson lattice as the lighter atoms become few.

3594 EXCITATION SPECTRUM OF AN ELECTRON AND ION SYSTEM IN A HOMOGENEOUS MAGNETIC FIELD. V.A.Yakovlev and A.V.Kalyush.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 308-10 (Aug., 1960). In Russian.

The effect of a magnetic field on the spectrum of the acoustic branch of the excitations of this system is studied with aid of the quantum kinetic equation. [English translation in: Soviet Physics - JETP (USA), Vol. 12, No. 2, 219-20 (Feb., 1961)].

3595 USE OF HIGH-FREQUENCY SOUND WAVES IN THE INVESTIGATION OF SOME ELECTRONIC PROPERTIES OF METALS. A.Myers.
Amer. J. Phys., Vol. 29, No. 3, 143-50 (March, 1961).

Some basic ideas are presented from an historical aspect, having regard to the behaviour of electrons in solids, particular reference being made to electrical conduction in both normal and superconducting metals. These ideas are used in the explanation of the mechanism causing electrons to attenuate high-frequency sound waves in metals, and the dependence of the attenuation on temperature and magnetic field is discussed. Tin and mercury are used as examples showing two extreme types of behaviour of the temperature dependence in superconductors, while the magnetic field dependence is described using gold as an example, details being given of how the shape of the Fermi surface can be obtained from the magnetic measurements.

3596 ULTRASONIC ATTENUATION IN NORMAL METALS AT LOW TEMPERATURES. A.B.Bhatia and R.A.Moore.
Phys. Rev. (USA), Vol. 121, No. 4, 1075-86 (Feb. 15, 1961).

Expressions for the attenuation α_d and α_t of plane dilatational and shear sound waves are obtained by solving the Boltzmann transport equation for the electron distribution function f without assuming the existence of a relaxation time τ for the collision term in this equation. Instead the collision integral is considered to arise explicitly from the interaction of electrons with thermal phonons and impurities. Making the usual "ideal metal" assumptions, it is found that the attenuation in general depends on a set of effective relaxation times τ_{LM} which are associated with the various terms in the expansion of f in a series of spherical harmonics $Y_{LM}(\theta,\varphi)$; the τ_{LM} are independent of the subscript M, and hence the same set $\{\tau_L\}$ determines both α_d and α_t. Explicit expressions for τ_L are derived. For the case in which all the τ_L equal to one another and equal of τ say, the analytical expressions for α_d and α_t obtained here are the same as those of Pippard (Abstr. 9499 of 1955). However, usually τ_L are not equal to one another. It is then found that when $\lambda \gg l$ (λ is the wavelength of the sound wave and l a mean free path of the electrons), τ in Pippard's expressions must be replaced by τ_2 and, contrary to what is usually assumed, α would not be in

general proportional to the electrical conductivity σ ($\sigma \propto \tau_1$). When $\lambda \ll l$, the attenuation, with one exception, is independent of $\{\tau_L\}$ and is the same as that given by Pippard. For $\lambda \sim l$, and τ_L not equal to one another, α may be calculated numerically if the ratios τ_L/τ_1 are known; the results of one such calculation show that the deviations from Pippard's analytical expressions are at most about 20%, provided τ in the latter is identified as τ_2. Finally, the possible influence of electron–electron collisions on attenuation is briefly discussed.

3597 NUCLEAR RESONANCE ABSORPTION OF ULTRASOUND IN KI AND KBr. G.S.Verma and S.K.Joshi.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 776 (Nov., 1960).

The experimental results of Bolef and Menes (Abstr. 11264 of 1959) are compared with Kessel's (Abstr. 9850 of 1960) theory of resonance absorption of ultrasound in paramagnetic nuclei. It is shown that the agreement is poor. S.A.Ahern

3598 ABSORPTION OF ULTRASOUND IN ZINC AT LOW TEMPERATURES. A.A.Galkin and A.P.Korolyuk.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 6, 1688-94 (June, 1960). In Russian.

Magnetic oscillations of the absorption coefficient of sound in zinc for several directions of the wave vector k relative to the crystallographic axes of the single crystal were studied under conditions when $l \gg \lambda$ (l is the electron mean free path and λ is the wavelength of sound). The magnetic field rotated in a plane perpendicular to vector k. In accordance with theory the oscillation period (in 1/H) was found to be constant. It was possible to find the extreme diameters of Fermi surfaces for a number of crystallographic directions from the magnitude of the period. From the anisotropy coefficient in a strong field it was found that the Fermi surface of zinc is open in the direction of the sixth-order symmetry axis. A new method of estimation of the mean free path of electrons is proposed. It is shown that for zinc the mean free path is anisotropic and varies between 0.2 and 0.6 mm. [English translation in: Soviet Physics — JETP (USA), Vol. 11, No. 6, 1218-22 (Dec., 1960)].

3599 A MECHANISM FOR ULTRASONIC ABSORPTION IN PARAMAGNETIC METALS IN A MAGNETIC FIELD. G.Z.Gershuni.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 362-3 (Aug., 1960). In Russian.

Variations of temperature and hence of the susceptibility of a metal will lead to currents and hence to an energy loss. An expression for this attenuation is derived and it is shown that for low frequencies it is proportional to the square of the frequency, while for high frequencies ($\omega \geq 10^8$) the attenuation reaches a limiting value. For dysprosium at 180°K (Néel temperature = 175°K) this limiting value is estimated at 2×10^{-3} cm^{-1}. [English translation in: Soviet Physics — JETP (USA), Vol. 12, No. 2, 256-7 (Feb., 1961)]. M.G.Priestley

3600 DECAY OF ACOUSTIC EXCITATIONS IN CRYSTALS. V.L.Pokrovskii and A.M.Dykhne.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 720-5 (Sept., 1960). In Russian.

The properties of acoustic excitation spectra are studied near the decay threshold in crystals. The damping of longitudinal phonons into transverse ones is found to be proportional to k^5. The effect of anisotropy of the phonon decay of transverse excitations is investigated. The weak coupling between acoustic vibrations implies a characteristic splitting of the spectrum near the decay threshold into two excitations with non-zero momenta. This peculiarity may be detected in neutron scattering experiments as two peaks in the energy distribution of neutrons scattered through an angle near the critical one. [English translation in: Soviet Physics—JETP (USA)].

3601 ADIABATICS OF SOUND PROPAGATION IN CRYSTALS. G.Leibfried and W.Ludwig.
Z. Phys. (Germany), Vol. 161, No. 5, 475-85 (1961). In German.

It is shown that the propagation of sound is an adiabatic process, and that sound velocities are determined by the adiabatic elastic data and the density in the usual way. The proof is analogous to that in simple monoatomic gases and takes anharmonic effects fully into account.

3602 ELASTIC WAVES IN TRIGONAL CRYSTALS. G.W.Farnell.
Canad. J. Phys., Vol. 39, No. 1, 65-80 (Jan., 1961).

In non-isotropic single crystals the normals to the wavefronts of elastic waves are not colinear with the vectors representing either the energy flow or the particle displacement. Calculations have been carried out on the propagation characteristics of sound waves in two particular trigonal crystals, α-quartz and sapphire The development of the eigenvalue equation for the velocity and the formulae for the components of the displacement and energy-flow vectors are summarized. The assumption that the wave has a plane wavefront normal to a given direction leads to three solutions, one representing a quasi-longitudinal wave and the other two representing quasi-transverse waves. The velocities of propagation, directions of displacement, and directions of energy flow for the three waves have been calculated for many orientations of the wave normal. Detailed results for propagation near one of the pure-mode axes are presented.

Thermal Properties

3603 QUANTUM-MECHANICAL CELL MODEL OF THE LIQUID STATE. II. APPLICATION TO THE ZERO-POINT PROPERTIES OF CLOSE-PACKED CRYSTALS. R.P.Hurst and J.M.H.Levelt.
J. chem. Phys. (USA), Vol. 34, No. 1, 54-63 (Jan., 1961).

The quantum-mechanical cell model previously developed for liquids (Abstr. 3505 of 1960) is adapted and used to evaluate zero-point properties of the noble gases, H_2 and D_2. Specifically, this theory is applied to determine the heats of sublimation, the zero-point energies and the equation of state for these gases at 0°K. By using the Lennard-Jones (6-12) intermolecular potential constants from second virial coefficient measurements as the only experimental parameters included in the theory, good agreement with the experimentally determined zero-point properties is generally obtained.

3604 THE MÖSSBAUER EFFECT IN TIN FROM 120°K TO THE MELTING POINT. A.J.F.Boyle, D.S.P.Bunbury, C.Edwards and H.E.Hall.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 129-35 (Jan., 1961).

Measurements were made of the intensity of the recoilless resonance absorption of the 24 keV γ-ray from the decay of Sn^{119m} in metallic tin from 120°K to the melting point. Values of the Debye–Waller factor deduced from the data tend towards the values calculated for a Debye Θ of 142°K at low temperatures; the behaviour of the Debye–Waller factor at higher temperatures indicates considerable anharmonicity of the lattice vibrations. Comparison with evidence from the thermal expansion and specific heat suggests that the quartic term in the interatomic potential is positive, and that the ratio of quartic to cubic terms is of the same order as the ratio of cubic to quadratic terms. In the last few degrees below the melting point the resonance absorption shows a rapid drop accompanied by an increase in line width. It is suggested that this effect is due to enhanced self-diffusion in the solid, and it is estimated that the diffusion coefficient reaches a value of 10^{-8} cm^2 sec^{-1} about 0.6°K below the melting point.

3605 LATTICE HEAT CAPACITY OF THE RARE EARTHS. HEAT CAPACITIES OF YTTRIUM AND LUTETIUM FROM 15-350°K. L.D.Jennings, R.E.Miller and F.H.Spedding.
J. chem. Phys. (USA), Vol. 33, No. 6, 1849-52 (Dec., 1960).

The heat capacities of lutetium and yttrium were measured and they are found to have the same dependence on a reduced temperature as does that of lanthanum. The lattice heat capacities are given by Θ values of 130.7, 166.0, and 213.7 for La, Lu, and Y and the corresponding electronic heat capacities are given by γ values of 100, 95, and 85 $\times 10^{-4}$ joule/g atom-deg^2.

3606 THE ATOMIC HEATS OF GOLD, PLATINUM AND ANTIMONY AT LIQUID HELIUM TEMPERATURES. K.G.Ramanathan and T.M.Srinivasan.
Proc. Indian Acad. Sci. A, Vol. 49, No. 2, 55-60 (Feb., 1960).

The specific heats of Au(99.97% purity) Pt(99.99%) and Sb(99.6%) were measured at 1.3-4.2°K, and were found to be

represented by:

$C_V(Au) = [(1.825 \pm 0.069)T + (1.049 \pm 0.010)T^3] \times 10^{-4}$ cal/°K,
$C_V(Pt) = [(15.956 \pm 0.100)T + (0.337 \pm 0.014)T^3] \times 10^{-4}$ cal/°K,
$C_V(Sb) = [(0.575 \pm 0.041)T + (0.525 \pm 0.013)T^3] \times 10^{-4}$ cal/°K.

R.F.Peart

3607 LATTICE AND ELECTRONIC SPECIFIC HEATS OF ZINC AND CADMIUM. T.M.Srinivasan.
Proc. Indian Acad. Sci. A, Vol. 49, No. 2, 61-5 (Feb., 1960).

The specific heats of Zn and Cd (99.95% purity) were measured at 1.3-4.2°K and were found to be represented by:

$C_V(Zn) = [(1.630 \pm 0.046)T + (0.143 \pm 0.009)T^3] \times 10^{-4}$ cal/°K,
$C_V(Cd) = [(1.518 \pm 0.138)T + (0.689 \pm 0.040)T^3] \times 10^{-4}$ cal/°K,

R.F.Peart

3608 THE EXTENSION OF HOUSTON'S METHOD WITH APPLICATION TO DEBYE Θ_0. D.D.Betts.
Canad. J. Phys., Vol. 39, No. 2, 233-8 (Feb., 1961).

Houston's method of integration over the unit sphere of functions of cubic symmetry is extended by developing integration formulae using 9 and 15 values of the integrand. The 3-, 6-, 9-, and 15-term Houston formulae are used to calculate Debye Θ_0 values for a number of cubic crystals. The convergence of the results is excellent except for the most anisotropic crystals.

LIMITING VALUE OF DEBYE TEMPERATURE FOR SUPERCONDUCTING AND NORMAL INDIUM. See Abstr. 2923

3609 ON THE THERMAL EXPANSION OF METALS AT LOW TEMPERATURES. G.K.Horton.
Canad. J. Phys., Vol. 39, No. 2, 263-71 (Feb., 1961).

A theory is developed which correlates the thermal expansion of crystals to the anharmonicity introduced into Born's lattice dynamics by allowing the force constants of the crystal to vary with volume. This is achieved by identifying the force constants with the elastic constants of the crystal by the method of long waves. It is then assumed that it is primarily the volume dependence of the elastic constants that gives rise to their temperature variation. A central-force nearest and next-nearest neighbour force model analogous to Leighton's is applied to copper. The values of the lattice thermal expansion coefficient and of Grüneisen's parameter are given as a function of the temperature and found to agree quite well with the latest experimental results. It is pointed out that the description of the interionic potential in metals by a two-body central force is certainly a serious oversimplification and that the theory is likely to be more realistic for, say, the ideal inert solid gases, as soon as the experimental data becomes available.

3610 THE EQUATION OF STATE OF IRON AT PRESSURES OF UP TO SEVERAL MILLIONS ATMOSPHERES.
V.N.Zharkov and V.A.Kalinin.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 4, 811-14 (Dec. 1, 1960).
In Russian.

Theoretical. Using iron as an example, presents a new method of deriving the equation of state of metals at ultra-high pressures with the aid of experimental Hugoniot adiabatics. [English translation in: Soviet Physics—Doklady (USA)]. M.H.Sloboda

3611 A CONTRIBUTION TO THE THEORY OF MELTING. I.P.Bazarov.
Dokl. Akad. Nauk SSSR, Vol. 135. No. 6, 1351-3 (Dec. 21, 1960).

Assuming that the frequency of atomic vibrations in a crystal is temperature-dependent, the existence of a critical temperature is established at which the vibrating motion breaks down. [English translation in: Soviet Physics—Doklady (USA)]. R.Eisenschitz

3612 ON THE SCATTERING OF PHONONS BY SPINS AT LOW TEMPERATURES. EXPERIMENTAL.
H.M.Rosenberg and B.Sujak.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 1299-1301 (Dec., 1960).

Some preliminary experiments are described which indicate how the heat conductivity of a dielectric crystal may be profoundly influenced by the presence of a small number of paramagnetic ions. Thermal conductivity measurements were performed in the temperature range 2°K to 20°K on crystals of Analar grade zinc sulphate both with or without the presence of the paramagnetic impurity $FeSO_4.7H_2O$. The presence of this impurity completely changed the temperature dependence of the thermal conductivity from $T^{-1.5}$ to about $T^{-0.5}$ and this change cannot be ascribed simply to an impurity scattering effect. It is suggested that this large decrease in conductivity is a consequence of Raman-type interactions between phonons and the low-lying spin levels of the ferrous ion.

R.Bullough

3613 ON THE SCATTERING OF PHONONS BY SPINS AT LOW TEMPERATURES. THEORETICAL. R.Orbach.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 1303-7 (Dec., 1960).

A theoretical interpretation of the previous paper (see preceding abstract) is given. By calculating the scattering cross-section for phonons in the presence of spin—phonon interactions the author provides a theoretical explanation of the temperature dependence of the thermal conductivity in presence of the paramagnetic impurity $FeSO_4.7H_2O$. R.Bullough

3614 QUANTUM OSCILLATIONS OF THE THERMAL CONDUCTIVITY OF AN ELECTRON GAS IN A MAGNETIC FIELD. V.V.Andreev and A.M.Kosevich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 741-5 (Sept., 1960).
In Russian.

Quantum oscillations of the thermal conductivity of conduction electrons in metals in a strong magnetic field H ($\omega\tau \gg 1$, $\omega = eH/mc$, τ the relaxation time) are computed at low temperatures ($kT \ll \zeta$, ζ is the chemical potential of the electron gas) when scattering of electrons on impurities is of decisive importance. It is shown that the oscillating part of the thermal conductivity can be expressed in a simple manner by oscillations of the electrical conductivity. [English translation in: Soviet Physics—JETP (USA)].

THERMAL CONDUCTIVITY OF Si–Cr ALLOYS. See Abstr. 3797

ELECTRON STATES

3615 APPLICATION OF THE GREEN FUNCTION METHOD TO THE MULTI-ELECTRON PROBLEM IN A SOLID. V.L.Bonch-Bruevich.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 590-600 (1958).
In Russian.

Plasma vibrations and the screening of the external field in a multi-electron system are studied. Attention is paid to the anisotropy of isoenergetic surfaces. By a series expansion of the mass and polarization operators in powers of the bond constants, explicit expressions are obtained for the plasma spectrum and the screening law. [English translation in: Phys. Metals and Metallography (GB). Vol. 6, No. 4, 13-21 (1958)].

3616 ENERGY OF AN ELECTRON IN A QUASI-PERIODIC FIELD. A.I.Rezanov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 601-8 (1958).
In Russian.

For the one dimensional case and the approximation of a strongly-bound electron, equations are obtained for the wave-functions and energy of an electron in a field of ions, whose configuration corresponds to a quasi-periodic potential variation. The permitted energy values form a set of two bands and are defined as statistical averages which can be calculated with distribution functions for the density in a non-ideal chain and inexact repetitions of the potential for shifts through quasi-periods. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 4, 22-9 (1958)].

3617 FRIEDEL SUM RULE FOR A SYSTEM OF INTERACTING ELECTRONS. J.S.Langer and V.Ambegaokar.
Phys. Rev. (USA), Vol. 121, No. 4, 1090-2 (Feb. 15, 1961).

For previous work, see Abstr. 17985 of 1960. The Friedel sum rule (Abstr. 3758 of 1952) is derived for a system of interacting electrons in a periodic potential.

3618 HARMONICITY OF ORBITALS AND COORDINATION. U.Panichi.
R.C. Accad. Naz. Lincei (Italy), Vol. 28, No. 5, 564-71 (May, 1960).
In Italian.

Relations between orbital radii and ion distances are discussed with reference to rocksalt, silvine and fluorite. A.R.Stokes

3619 BAND STRUCTURE OF CdS.
M.Balkanski and J.des Cloizeaux.
Abhandl. Deutschen Akad. Wiss. Berlin, Kl. Math. Phys. Tech. (Germany), 1960, No. 7, 76-83. In French.

"Electron processes in solids" Conference (see Abstr. 2382 of 1961). A description is given of the quantum classification and the crystallographic point symmetry of the extrema of the conduction and valence bands of CdS. The energy curves are symmetrical about the zone centre in momentum space, but the extrema of the conduction band and two of the valence bands occur away from the zone centre. The highest valence band has its maximum at k = 0. From the difference between the absorption limits for light polarized parallel and perpendicular to the z-axis it is concluded that the two highest valence bands are separated by 0.016 eV. Indirect transitions occur at the absorption limit. The allowed transitions may be recognized and classified from the associated exciton absorption line series. Consideration of the detailed nature of the energy bands shows that for light polarized perpendicular to the crystal axis there will be two observable levels for each transition to the exciton ground state. With light polarized parallel to the axis, only one level should be observed. P.J.Dean

3620 SPLITTINGS OF d^n-TERMS IN STRONG COMPLEX FIELDS OF TRIGONAL AND RHOMBIC SYMMETRIES.
F.J.Gilde and M.I.Bán.
Acta phys. Hungar., Vol. 12, No. 1, 13-34 (1960).

Group-theoretical analysis of the d-electron configurations in strong fields of D_{3d} and D_{2h} symmetries, with detailed tabulation of the orbital products occurring in the splitting configurations, for application to the crystal-field theory of transition-metal complexes. (See Abstr. 2591-2, 5996 of 1955). J.Hawgood

3621 ELECTRON ENERGY LEVELS IN CRYSTALS. I. THALLIUM-ACTIVATED ALKALI HALIDES.
M.Balarin.
Ann. Phys. (Germany), Vol. 6, No. 3-4, 120-30 (1960). In German.

Using the central ion model the effect of different halide lattices on the energy levels of Tl^+ ions is investigated. Experimental data can be explained if the lattice ions are not treated as point charges but as having spatially distributed electronic charges. G.F.J.Garlick

3622 SYMMETRY OF THE ENERGY BANDS IN TlSe-TYPE CRYSTALS. F.M.Gashimzade.
Fiz. tverdogo Tela (USSR), Vol. 2, No.,12, 3040-4 (Dec., 1960). In Russian.

Group-theory methods are used to deal with crystals of D_{4h}^{18} space-group symmetry. The structure of energy bands near their extrema is discussed. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3623 THE ELECTRONIC STRUCTURE OF GRAPHITE.
J.Barriol.
J. Chim. phys. (France), Vol. 57, No. 10, 837-43 (Oct., 1960). In French.

A review of theoretical treatments and of current ideas on the band structure of graphite. L.Pincherle

3624 THE π ELECTRON PROPERTIES OF GRAPHITE.
T.E.Peacock.
J. Chim. phys. (France), Vol. 157, No. 10, 844-7 (Oct., 1960).

The approximations of self-consistent field molecular orbital theory as applied to π electron molecules have recently been extended to the infinite two-dimensional graphite sheet (Abstr. 4277 of 1960). In the note, the results obtained are used to discuss certain physical properties of graphite. T.E.Peacock

3625 APPLICATION OF THE METHOD OF MOLECULAR ORBITALS TO GRAPHITE. J.Barriol and J.Metzger.
J. Chim. phys. (France), Vol. 57, No. 10, 848-54 (Oct., 1960). In French.

The authors apply molecular orbital theory to the case of graphite fragments of constant width. The numerical calculations are effected for a width of twelve rings, The curves of the distribution of energy levels and the variation of bond orders are discussed. T.E.Peacock

3626 A NOTE ON THE SELECTION RULES FOR OPTICAL TRANSITIONS IN ALLOYS. J.M.Ziman.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 757-8 (July, 1960).

The transition probability of indirect transitions involving the virtual scattering of electrons by impurities is estimated using perturbation theory. In some noble metal alloys these may be of comparable importance to direct optical transitions. H.Mykura

3627 APPROXIMATE CALCULATION OF THE ANISOTROPY OF THE RELAXATION TIME OF THE CONDUCTION ELECTRONS IN THE NOBLE METALS. J.M.Ziman.
Phys. Rev. (USA), Vol. 121, No. 5, 1320-4 (March 1, 1961).

The ratio of the relaxation times on the "belly" and on the "necks" of the Fermi surface is estimated numerically by very crude methods. It is shown that the relative amount of s-wave to p-wave scattering by impurities is important and that umklapp processes play a major role in phonon scattering. The ratio depends on impurity type and on temperature in just the right way to explain qualitatively the variation of the Hall coefficient in the metals and their alloys.

3628 CONTRIBUTION OF EXCHANGE POLARIZATION OF CORE ELECTRONS TO THE MAGNETIC FIELD AT THE NUCLEUS OF Fe. D.A.Goodings and V.Heine.
Phys. Rev. Letters (USA), Vol. 5, No. 8, 370-1 (Oct. 15, 1960).

Recent experiments (Abstr. 11827 of 1960) on the hyperfine spectrum of Fe^{57} show the effective magnetic field at the nucleus in ferromagnetic iron is directed oppositely to the magnetization, with a value of −333 kG. An unrestricted Hartree–Fock calculation is reported which confirms that this large negative value arises from the contact interaction of core s-electrons. Good agreement with the experimental value is obtained on the assumption that the 3d electrons in the metal are 5 to 10% more spread out than in the free ion and that the amount of 4s admixed into the 3d band is rather small. D.M.Edwards

3629 CONTRIBUTION OF THE FERMI CONTACT TERM TO THE MAGNETIC FIELD AT THE NUCLEUS IN FERROMAGNETS. A.J.Freeman and R.E.Watson.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 498-500 (Dec. 1, 1960).

Describes unsuccessful "spin-polarized" Hartree–Fock calculations designed to explain the negative sign of the effective magnetic field at the Fe^{57} nucleus in iron (Abstr. 11827 of 1960). E.P.Wohlfwarth

3630 ENERGY BANDS IN PARTIALLY DISORDERED BINARY ALLOYS. A.Corciovei and D.Grecu.
Rev. de Physique (Roumania), Vol. 5, No. 2, 157-67 (1960).

Starting with a perfectly ordered alloy, for which the energy bands are supposed to be known, the disorder is introduced as a perturbation, and the energy corrections computed in the almost free electron approximation. The width of certain forbidden bands decreases with increasing disorder and becomes zero for complete disorder. L.Pincherle

3631 BAND STRUCTURE OF THE LAYER LATTICE OF THE BISMUTH TYPE. E.Behrens.
Z. Phys. (Germany), Vol. 161, No. 3, 279-95 (1961). In German.

Tight-binding calculations were performed on a two-dimensional model and on a cubic lattice, and the band structure was estimated for the whole range between the two limiting cases. Strongly anisotropic overlapping of an almost full and an almost empty band is indicated near the trigonal axis in all cases. L.Pincherle

3632 ON THE THEORY OF SURFACE STATES.
J.Koutecký.
J.Phys. Chem. Solids (GB), Vol. 14, 233-40 (July, 1960).

A critical survey of existing theoretical ideas on the electronic states localized at a crystal surface, with original remarks. L.Pincherle

3633 SOME PROBLEMS OF THE ELECTRON THEORY OF METALS. I. CLASSICAL AND QUANTUM THEORY OF ELECTRONS IN METALS. I.M.Lifshitz and M.I.Kaganov.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 3, 419-58 (Nov., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 6, 831-55 (June, 1960).

Mainly a review, based on the approach and results of the Khar'kov theoretical group, but some of the results are published here for the first time. This first part starts with a discussion of the geometry of the constant-energy surfaces for electrons, the electrons here being considered to form an ideal gas of Fermi quasi-particles which replaces the set of valence electrons interacting with each other and with the crystalline field. Then follow the classical and quantum treatments of particles with arbitrary dispersion relations and of their collisions. A special section deals with the energy levels in a magnetic field. L.Pincherle

ANGULAR CORRELATION OF GAMMA QUANTA FROM ELECTRON–POSITRON ANNIHILATION IN BISMUTH. See Abstr. 3151

3634 INTERACTION OF A POLARIZABLE POTASSIUM CHLORIDE CRYSTAL WITH A VALENCE-BAND HOLE.
S.J.Nettel.
Phys. Rev. (USA), Vol. 121, No. 2, 425-35 (Jan. 15, 1961).

The interaction of a valence-band hole with a KCl crystal, when crystal–hole correlations are considered, is studied by variational means. Initially a crystal trial wave-function is constructed which allows for the ionic polarizability of the crystal by means of a correlation between the crystal configuration and the motion of the hole. The expectation value of the Hamiltonian operator for the crystal is found by integrating over both electronic and nuclear coordinates. The necessary matrix elements of the electronic energy operators are taken from a previous calculation by Howland (Abstr. 2645 of 1958). The total energy expectation is minimized with respect to a single parameter in the wave-function that measures the hole–lattice correlation. One finds that the valence bands obtained when the crystal lattice is treated as rigid become completely flat, a result which implies that the hole is self-trapped. The modifications that are introduced by the addition of the electronic polarizability are studied by repeating the previous calculation with a refined wave-function. Only a rough treatment drawing on the experimental electronic polarizabilities of the crystal ions is given. Information on self-trapped holes in KCl derived from the electron spin resonance experiments of Castner and Känzig [J. Phys. Chem. Solids, Vol. 3, 178 (1957)] is briefly considered.

COLLECTIVE EXCITATIONS OF ELECTRONS IN DEGENERATE BANDS. See Abstr. 3883

3635 PRESENT POSITION OF EXCITON RESEARCH IN SEMICONDUCTORS. H.Haken.
"Semiconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 1-49. In German.

The theory of excitons is reviewed for the extreme cases of the electron and the hole situated in the same lattice cell, and being separated by a distance large compared with the lattice constant, thus justifying the treatment of excitons as point charges. The latest views on exciton mechanism are reported, including the author's theory of the relationship between the dielectric constant and the orbital radius of the exciton and a general extension of the wave-vector selection rule. Excitons in external fields and in thermal and photoconductive processes are treated, followed by accounts of experiments on various crystals, utilizing optical and photoelectric methods. A.Landman

3636 DIRECT OBSERVATION OF EXCITON MOTION IN CdS. D.G.Thomas and J.J.Hopfield.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 505-7 (Dec. 1, 1960).

The Zeeman splitting of the n = 2 exciton state in CdS(H perpendicular to c-axis) was measured in the presence of a variable electric field applied perpendicular to H and to the wave vector of the absorbed photons. The momentum given to the excitons during their creation by the photons produced an internal electric field along the axis of the external electric field. This internal field displaced the symmetry plane of the Stark splitting of the exciton state. The mean displacement of this symmetry plane was measured for the two directions of the magnetic field under conditions in which the effects of polarization screening and the piezoelectric effect were found to be negligible. The exciton mass calculated from the displacement field was specimen dependent and generally larger than that calculated directly from the Zeeman spectra. It is suggested that this was due to the presence of an appreciable Hall field in the direction of photon propagation. The magnitude of this field depended upon the Hall angle and therefore on the degree of perfection of the sample. P.J.Dean

3637 EXCITON SPECTRA OF MIXED CRYSTALS. G.Maier.
Z. Phys. (Germany), Vol. 160, No. 5, 527-34 (1960). In German.

The absorption exciton lines of cuprous oxide can also be found in mixed crystals containing silver. The series limit moves smoothly to longer wavelengths as the concentration is increased, but the "Rydberg" constant does not change. From the shift and broadening of the lines a statistical estimate of the increase in size of the crystal can be made which determines the position of the exciton levels relative to the valence band. G.F.J.Garlick

3638 AN EXPERIMENTAL DETERMINATION OF THE MASS OF A POLARON IN COPPER OXIDE.
N.I.Krivko and N.M.Reinov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6(12), 1850 (Dec., 1960). In Russian.

A single crystal at 4.2°K was illuminated by white light and in a magnetic field of up to 25 kG. Measurements of absorption as a function of field gave effective-mass values of 5.8 and 6.6 m_0. [English translation in: Soviet Physics–JETP (USA)]. M.G.Priestley

3639 ELECTRON DISTRIBUTION IN TRANSITION METALS. A.J.Freeman and R.J.Weiss.
Phil. Mag. (Eighth Ser.) (GB), Vol.4, 1086-8 (Sept., 1959).

By considering charge distributions of cubic symmetry but of exaggerated asphericity it is shown that, contrary to the suggestion made by Hume-Rothery et al. (Abstr. 515 of 1960), asphericity alone cannot account for Weiss and DeMarco's X-ray results on Fe and Cr (Abstr. 3583 of 1958). Only large changes in radial charge densities can account for these results. D.M.Edwards

3640 GIANT SPIN DENSITY FLUCTUATIONS. J.C.Phillips.
Phil. Mag. (GB), (Eighth Ser.), Vol. 5, 1193-4 (Nov., 1960).

It is shown that Overhauser's result (Abstr. 13513 of 1960) on the existence of spin-density fluctuations in a system of interacting fermions is peculiar to a one-dimensional model. Reasons are given for the breakdown of Overhauser's suggested generalization to two and three dimensions. D.M.Edwards

3641 EXCITATIONS IN A HIGH DENSITY ELECTRON GAS. I. T.Usui.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 787-98 (May, 1960)

A systematic method is developed which permits an electron gas to be described in terms of bosons. This boson corresponds to an "exciton", i.e., a pair of an electron outside the Fermi sphere and a hole inside. The formalism is particularly suitable for the system at high density, as suggested by Sawada's discussion of the same system (Abstr. 6374 of 1957). As an application, the effect of electron exchange on the plasma frequency is calculated. The result coincides with that of a Hartree–Fock treatment.

3642 EXCITATIONS IN A HIGH DENSITY ELECTRON GAS. II. DIAMAGNETISM. E.Fujita and T.Usui.
Progr. theor. Phys. (Japan), Vol. 23, No. 5, 799-809 (May, 1960).

As a further application of the method of describing a high-density fermion gas in terms of electron–hole pairs, the diamagnetism of the gas is investigated. The two corrections to the Landau diamagnetism which are obtained come from the screened interaction of exchange type. Stress is laid on the effectiveness of the physical concept of electron–hole pair excitation.

3643 QUANTUM OSCILLATIONS OF THERMODYNAMIC PROPERTIES FOR AN ARBITRARY FERMI SURFACE. M.Ya.Azbel'.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 878-87 (Sept., 1960). In Russian.

Thermodynamic properties of an electron gas in a metal in a constant magnetic field H are calculated in the general case of a non-convex Fermi surface. It is shown that the presence of trajectories with self-intersection leads to quantum oscillations of these quantities as a function of H. It is pointed out that the experimentally observed oscillations corresponding to "anomalously weakly filled" bands may be due either to separated small surfaces and are then described by the Lifshits–Kosevich theory (Abstr. 8862 of 1956) or by small convexities or depressions in the main large band in which case they are described by the present theory. [English translation in: Soviet Physics–JETP(USA)].

3644 EFFECT OF ELECTRON EXCHANGE ON THE DISPERSION RELATION OF PLASMONS. O.von Roos and J.S.Zmuidzinas.
Phys. Rev. (USA), Vol. 121, No. 4, 941-2 (Feb. 15, 1961).

A calculation of the influence of electron exchange on the dispersion relation of a high-density electron gas at 0°K is described. The result is compared with those obtained by various authors using different methods.

3645 GREEN FUNCTION METHOD FOR ELECTRON GAS. I. GENERAL FORMULATION. H.Kanazawa and M.Watabe.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 408-25 (March, 1960).

It is emphasized that there is a perfect parallelism between the Green's function methods in zero-temperature problems and in finite-temperature problems of systems in thermal equilibrium. Further it is pointed out that the Green's function method is also useful for the calculation of transport quantities.

3646 GREEN FUNCTION METHOD FOR ELECTRON GAS. II. DISPERSION RELATION OF PLASMONS.
H.Kanazawa, S.Misawa and E.Fujita.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 426-32 (March, 1960).

The shift of plasmon energy due to electron exchange is calculated. The result is the same as that obtained by Nozières and Pines (Abstr. 2107 of 1959). An analysis of the experimental values of Watanabe (Abstr. 2177 of 1956) referring to Bohm–Pines' values is made and the agreement between theory and experiment is good at high densities.

3647 GREEN FUNCTION METHOD FOR ELECTRON GAS. III. DIAMAGNETISM. H.Kanazawa and N.Matsudaira.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 433-46 (March, 1960).

The Green's function method is applied to the calculation of the diamagnetic susceptibility of a dense electron gas. The exact high density value for the correction to the Landau diamagnetism is calculated.

3648 DECAY OF A PLASMON AT ABSOLUTE ZERO. Yu.A.Romanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 662-5 (Sept., 1960). In Russian.

Considers the decay of a plasmon in a solid (isotropic model) due to phonon interaction between electrons. [English translation in: Soviet Physics–JETP (USA)].

3649 A NEW RESONANCE EFFECT IN METALS AT HIGH FREQUENCIES. M.Ya.Azbel'.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 400-12 (Aug., 1960). In Russian.

The current density (j) and electric field strength (E) pattern are investigated at frequencies exceeding those for which cyclotron resonance occurs. It is shown that in the case of resonance, j and E on the central cross-section of the Fermi surface (provided the latter is not an ellipsoid) vary in a very peculiar manner with the depth y. At a not too large depth ($y \leq d^2/\delta_0$, d is the Larmor orbit diameter, δ the skin layer depth, $d \geq \delta_0$) the field strength and current exhibit a pronounced peak not only on the surface of the metal but also for $y \cong d, 2d, 3d, \ldots$ For $y >\sim d^2/\delta_0$, the field and current oscillate along distances of the order of d with a damping depth of the order d^2/δ_0. Some new effects are predicted, such as discontinuities in the resonance impedance under resonance conditions and the discontinuous disappearance of resonance on harmonics in plates with a thickness $D \geq d$: (1) when the frequency of the field increases and (2) when a constant magnetic field is rotated in the plane of the film; selective transparency of films in resonance; an electron "echo". A study of the impedance of plates permits one to plot the Fermi surface directly. It is shown, moreover, that in a number of semiconductors and poor metals, cyclotron resonance takes place instead of diamagnetic resonance. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 2, 283-91 (Feb., 1961)].

CYCLOTRON RESONANCE IN GERMANIUM AND SILICON AND THE EFFECT OF NEGATIVE EFFECTIVE MASSES. See Abstr. 3755

3650 ENERGY LOSS OF ELECTRONS PASSING THROUGH A GRAPHITE SINGLE CRYSTAL AT DIFFERENT INCIDENT ANGLES. H.Watanabe.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1453 (Oct., 1959).

Reports measurements showing that the characteristic energy loss suffered by electrons passing through graphite does not depend on angle of incidence. From the measurements it was possible to deduce that the resonance energy between nearest neighbours in the lattice was 1.63 eV, in good agreement with previous estimates.
A.E.I.Research Laboratory

DEFECT PROPERTIES

3651 X-RAY INVESTIGATIONS OF LATTICE DEFECTS IN MIXED CRYSTALS. V.Gerold.
Ergeb. exakt. Naturwiss. (Germany), Vol. 33, 70 pp. (1961). In German.

Review article.

3652 INVESTIGATIONS OF CRYSTAL PERFECTION IN SEMICONDUCTOR CRYSTALS. G.H.Schwuttke.
Sylvania Technol. (USA), Vol. 13, No. 4, 122-8 (Oct., 1960).

Chemical etching, decoration and X-ray diffraction microscopy are evaluated for use in the investigation of defects in semiconductor crystals. Photographs, illustrating results obtained by the various methods, and a list of suitable chemical etchants, are included. 31 references.

3653 SPIN RESONANCE STUDIES OF DEFECTS IN MAGNESIUM OXIDE.
J.E.Wertz, P.Auzins, J.H.E.Griffiths and J.W.Orton.
Disc. Faraday Soc. (GB), No. 28, 136-41 (1959).

"Crystal imperfections" discussion (see Abstr.2386 of 1961). Excluding impurities, trapped holes are the most important defect centres which are observable by electron-spin resonance in presently-available magnesium oxide crystals. Models are suggested for two types of trapped hole centres. The first, involving one hole, is believed to involve the following linear array: hole trapped on an oxygen atom — positive ion vacancy — normal O^{2-} ion—trivalent impurity ion. The second centre, which is far less stable, involves two holes opposite one another about a positive-ion vacancy. It is suggested that another defect is associated with this pair to cause localization of the axis of symmetry. These conclusions are drawn from electron-spin resonance spectra showing simple axial symmetry for single-hole centres lying along principal crystal axes. For hole–pair centres one observes pair of lines approximately centred upon the positions of the previously-mentioned axial lines. More complex hole centre spectra were also observed.

3654 CALORIMETRIC DETERMINATION OF THE FORMATION ENERGY OF VACANCIES IN GOLD.
V.A.Pervakov and V.I.Khotkevich.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 6, 1328-30 (Oct. 21, 1960). In Russian.

The heat evolved in annealing gold wires quenched at various temperatures is measured by a calorimetric method described earlier [Fiz. Metallov i Metallovedenie (USSR), Vol. 6, 1061 (1958)], and is shown to be linearly related to change of the electrical resistance. The energy of formation of one vacancy is estimated as 19 000 cal/g-atom. The dependence of the vacancy concentration on temperature and of the electrical resistance on the vacancy concentration are also discussed. [English translation in: Soviet Physics – Doklady (USA)]. R.F.S.Hearmon

3655 PARAMAGNETIC RESONANCE STUDY OF IRRADIATED SINGLE CRYSTALS OF CALCIUM TUNGSTATE.
H.Zeldes and R.Livingston.
J. chem. Phys. (USA), Vol. 34, No. 1, 247-52 (Jan., 1961).

Gamma irradiation of calcium tungstate at 77°K produces two paramagnetic species in high yield. Measurements of yields and of rates of disappearance upon warming indicate the two species are formed and disappear upon warming in one to one correspondence. The principal axis directions and g tensors were measured and indicate that one species contains a surplus electron while the other is electron-deficient (hole). Hyperfine effects of W^{183} were observed. The electron-deficient species contains two tungsten atoms with small isotropic hyperfine interactions. Its unpaired electron must be highly localized in orbitals of atoms other than tungsten. The electron-surplus species contains one tungsten atom with an anisotropic hyperfine interaction. This centre could be WO_4^{3-}, but from the lack of symmetry of the measured g values it must be formed near a lattice defect. Experiments with heat-treated crystals indicate lattice defects to be important in the radiation effect.

3656 DEFECTS IN IRRADIATED SILICON. I. ELECTRON SPIN RESONANCE OF THE Si–A CENTER.
G.D.Watkins and J.W.Corbett.
Phys. Rev. (USA), Vol. 121, No. 4, 1001-14 (Feb. 15, 1961).

The Si–A centre is a major radiation-damage defect produced

in "pulled" silicon by room temperature irradiation. As a result of studies described in the paper and Pt II, it is concluded that this centre is a lattice vacancy with an oxygen atom purity bridging two of the four broken bonds associated with the vacancy. Spin resonance and electrical activity arise from an electron trapped in the other two bonds. The spin resonance studies are described; a molecular orbit treatment of the trapped electron wave-function satisfactorily accounts for the observed g-tensor, as well as the hyperfine interaction observed with neighbouring 4.7% abundant Si^{29} nuclei. Study of the changes in the spectrum of a sample subjected to uniaxial stress are also described. Under stress, the amplitudes of the individual resonance components (which correspond to different orientations of the defect in the crystal) are observed to change. This results from (1) electronic redistribution of the trapped electrons among the defects, and (2) thermally activated reorientation of the defects themselves under the applied stress. These two effects are separated and a quantitative study of their magnitudes and signs, as well as their rates, is given. The results confirm many of the important microscopic features of the model.

3657 DEFECTS IN IRRADIATED SILICON. II. INFRARED ABSORPTION OF THE Si–A CENTER.
J.W.Corbett, G.D.Watkins, R.M.Chrenko and R.S.McDonald.
Phys. Rev. (USA), Vol. 121, No. 4, 1015-22 (Feb. 15, 1961).

Infrared measurements are presented which, in conjunction with the spin resonance measurements of the preceding paper, establish the identity of the Si–A centre. A new infrared absorption band is observed at 12μ in electron-irradiated silicon. This band is shown to be a vibrational band of impurity oxygen in the lattice. Macroscopic and microscopic correlations between the 12 μ band and the spin resonance of the Si–A centre are presented. The macroscopic correlations are of production rate, recovery, etc. The microscopic correlations derive from the absorption of polarized infrared radiation by samples of various crystallographic orientations, subjected to a uniaxial, compressive stress. Partial alignment of the defects is induced by the stress and is detected as a dichroism in the 12 μ band. This alignment is compared to the corresponding alignment studies in the spin resonance measurements in Pt I. It is shown that the kinetics and magnitude of the response to the stress are the same for the defects observed in both types of measurements. This shows that the 12 μ band arises from the Si–A centre and established the configuration of the oxygen in the defect. These results, together with the results of Pt I, satisfy the conclusion that the Si–A centre is a lattice vacancy with an oxygen atom bridging two of the four broken bonds associated with the vacancy. The remaining two bonds can trap an electron, giving rise to the spin resonance spectrum of the defect. The identification of the Si–A centre indicates that the vacancy is mobile in a room-temperature irradiation.

3658 REMARKS ON THE RECOMBINATION OF FRENKEL PAIRS IN THE CRYSTAL AND AT DISLOCATIONS.
O.Stasiw and J.Teltow.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany),1960, No. 7, 295-307. In German.

"Electron processes in solids" conference (see Abstr. 2382 of 1961). Defect kinetics is discussed for silver halide crystals, using a semiempirical point of view based on mass-action laws. The order of magnitude of the parameters which enter such theories is estimated. P.T.Landsberg

3659 OBSERVATION OF INTERSTITIAL ATOMS IN F.C.C. METALS. A.Seeger, P.Schiller and H.Kronmüller.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 853-7 (Aug., 1960).

Interstitial atoms in face-centred cubic metals are thought to exist in the form of intersticialcy pairs with tetragonal symmetry, and relaxation effects due to rotation of the pairs should occur Internal friction and magnetic susceptibility measurements on drawn nickel wire were made and are interpreted in terms of interstitial pair rotation. The activation energy is (0.79 ± 0.03) eV and the activation energy for migration about 1 eV. H.Mykura

3660 THE EFFECT OF ELECTROPOLISHING ON THE RETENTION OF VACANCIES DURING QUENCHING IN Al AND Al ALLOYS. E.J.Freise, M.E.Fine and A.Kelly.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 101-3 (Jan., 1960).

Small-angle X-ray scattering was measured on thin foils of Al and Al–6% Ag alloy quenched from 540°C. Electropolished and etched, and only electropolished foil was used, the latter giving more small-angle scattering. The scattering is attributed to dislocation loops formed by quenched-in vacancies. The electropolished foils are thought to have surface oxide layers which reduce the escape of vacancies to the surface, while etching removes the oxide layer, allows vacancies to escape and thus gives less small-angle scattering. H.Mykura

3661 AN EFFECT OF IMPURITY ATOMS ON THE ENERGY RELATIONSHIP OF (100) AND (110) SURFACES IN HIGH PURITY SILICON IRON. J.L.Walter and C.G.Dunn.
Acta metallurgica (Internat), Vol. 8, No. 8, 497-503 (Aug., 1960).

The migration of grain boundaries between (110) grains and (100) grains in high purity 3% silicon iron sheet was investigated at 1200°C to determine whether or not impurity atoms could effect a reversal in the direction of boundary migration. Boundaries were found that advanced into the (100) grains in a vacuum anneal, then reversed their direction of migration and advanced into the (110) grains in a subsequent anneal in impure argon, and then reversed back to the initial direction of migration in a final vacuum anneal. Evidence was found for surface energy driving forces in both kinds of anneals. In the anneals in argon, but not in vacuum, the surfaces of the (100) grains were thermally etched. The results could be satisfactorily explained on the basis that the impure argon supplied oxygen atoms and that the vacuum anneals removed oxygen. The conclusions reached were (a) under proper conditions impurity atoms can effect a reversal in the direction of boundary migration, (b) $\gamma_{110} < \gamma_{100}$ in the vacuum anneals and $\gamma_{100} < \gamma_{110}$ in the anneals in impure argon, (c) the effect of the impurity is to reduce γ_{100} more than γ_{110} and (d) the high density plane, (110), is not always the low energy plane.

3662 SOLUBILITY OF OXYGEN IN GERMANIUM.
W.Kaiser and C.D.Thurmond.
J. appl. Phys. (USA), Vol. 32, No. 1, 115-18 (Jan., 1961).

The infrared absorption band at 11.7 μ corresponding to a germanium–oxygen molecular vibration is quantitatively correlated to the chemically determined oxygen content of germanium crystals. The solid solubility of oxygen is determined as a function of temperatures and the precipitation of the second phase GeO_2 is observed. Crystals containing about 10^{17} atoms per cm^3 of dissolved oxygen were prepared. The maximum solubility appears to be 2×10^{18} atoms/cm^2. The heat of solution is 1.2 eV. Silicon in a melt of germanium acts as a getter for oxygen, resulting in the formation of SiO_2; this observation is in agreement with thermodynamical considerations.

3663 A POLARIZABLE POINT-LATTICE APPROXIMATION IN THE THEORY OF IMPURITY CENTRES IN IONIC CRYSTALS. I.V.Abarenkov.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 418-20 (Sept., 1960). In Russian.

Develops a method, called a polarizable point-lattice approximation, which is as simple as the rigid point-lattice approach, although it allows for motion of ions. The new method is applied to an NaCl crystal at 0°K and good agreement with experiment is found. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 218-19 (Sept., 1960)]. A.Tybulewicz

3664 THE STRESS FIELDS AROUND SOME DISLOCATION ARRAYS. A.K.Head.
Austral. J. Phys., Vol. 13, No. 3, 613-15 (Sept., 1960).

Explicit expressions for the stresses around various edge dislocation arrays are given. The discrete dislocations are replaced by a continuous dislocation density (Abstr. 580 of 1952). R.Bullough

3665 SOME ELASTIC PROPERTIES OF AN EDGE DISLOCATION WALL. J.C.M.Li.
Acta Metallurgica (Internat.), Vol. 8, No. 8, 563-74 (Aug., 1960).

A detailed elastic theory calculation is given to reveal the stress field of a dislocation wall consisting of a finite number of uniformly spaced edge dislocations of the same slip vector. The wall is normal to the slip plane. It is found that only at distances from the wall closer than the dislocation spacing in the wall does the stress field begin to resemble that of a simple tilt boundary or of a wall containing an infinite number of dislocations. At large distances from the wall, the stress field approaches that of a single dislocation with a Burgers' vector equal to the sum of the Burgers' vectors of all dislocations in the wall. Based on the calculated stress field, the process of polygonization is illustrated and some rate laws are suggested concerning the growth of a wall and the coalescence of two walls. The interaction of solute atoms with a

finite dislocation wall is discussed in terms of the dilatational strain field which is also quite different from that of an infinite wall. The strain energy of a dislocation wall is calculated and compared with that of a set of randomly distributed dislocations to confirm the energetics of polygonization. Finally, some mechanical properties are discussed in terms of the ability of a dislocation wall to resist the penetration of approaching dislocations and its contribution to the brittleness of the material.

3666 SOME EFFECTS OCCURRING IN DISLOCATED TELLURIUM.

J.S.Blakemore, J.W.Schultz and K.C.Nomura.
J. appl. Phys. (USA), Vol. 31, No. 12, 2226-31 (Dec., 1960).

Dislocation densities as small as 1000 cm^{-2} are sometimes found in carefully produced single crystals of tellurium, but since the material is very soft a quite mild stress can introduce 10^6 dislocations/cm^2 or more. Dislocation etch pits of sharply geometric shape can be developed on the cleavage $(10\bar{1}0)$ planes by the slow attack of sulphuric acid; their planar surfaces correspond to $(1\bar{1}00)$, $(10\bar{1}3)$, $(01\bar{1}1)$, and $(0\bar{1}1\bar{1})$ faces. Effects are noted on faces exposed by cleavage at 77°K which suggest than even at this temperature the material can suffer localized plastic damage, for brief etching of such faces produces small flat-bottomed pits; these may be interpreted by supposing that the mild stress of cleavage at 77°K generates shallow dislocation loops. The flat-bottomed pits disappear when a surface layer $\geq 25\ \mu$ is etched away. A marked increase in electron-hole recombination rate is noted in plastically deformed crystals. If the additional recombination occurs through the dislocations themselves, then each has a capture radius of some 4×10^{-8} cm at 300°K. Dislocated crystals also show more prominent trapping effects at low temperatures than structurally pure samples, and contain additional readily ionizable acceptor sites; these may be derived from the dislocations themselves or from other defects created or activated by plastic flow.

3667 AN ANALYSIS OF THE SPATIAL DISTRIBUTION OF DISLOCATIONS IN CADMIUM.

A.A.Predvoditelev, N.A.Tyapunina and A.S.Bȳstrikov.
Kristallografiya (USSR), Vol. 5, No. 3, 432-6 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 407-12 (Nov.-Dec., 1960).

Studied with the aid of continuous etching and cinematography under a microscope. The presence of dislocation configurations corresponding to the Frank–Read sources was confirmed.

3668 DEVELOPMENT OF DISLOCATIONS IN CALCITE CRYSTALS.

V.Z.Bengus, F.F.Lavrent'ev, L.M.Soifer and V.I.Startsev.
Kristallografiya (USSR), Vol. 5, No. 3, 441-5 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 418-22 (Nov.-Dec., 1960).

A method of selective etching of dislocations in calcite is presented, and it is shown that etch pits on the cleavage plane correspond to the exits of dislocation lines. It is also shown that dislocations concentrate at the boundary between a twin layer and the original crystal. "Etch bands" of a dislocational nature have been discovered.

3669 "CONSERVATIVE CLIMB" OF A DISLOCATION LOOP DUE TO ITS INTERACTION WITH AN EDGE DISLOCATION. F.Kroupa and P.B.Price.
Phil. Mag. (GB), Vol. 6, 243-7 (Feb., 1961).

A new type of dilocation motion, called "conservative climb" was observed in zinc platelets deformed in tension inside an electron microscope. Circular, prismatic dislocation loops are often forced to climb out of their glide cylinders by their repulsive interaction with edge dislocations. It is observed that the area inside a loop is conserved during its movement, from which it is concluded that the climb occurs, not by self-diffusion, but by the transfer of vacancies around the loop by pipe diffusion. Calculations of the interaction energy, of the total forces on the loop, and of the forces per unit length on the elements of the loop show that conservative climb can be expected to occur when the temperature is not too low and the separation of loop and edge dislocation is small.

3670 INTERACTIONS BETWEEN DISLOCATIONS WITH BURGERS VECTORS AT 120° IN CRYSTALS OF SILVER BROMIDE. J.T.Bartlett and J.W.Mitchell.
Phil. Mag. (GB), Vol. 6, 271-5 (Feb., 1961).

A detailed analysis is given of examples of the combination, in crystals of silver bromide, of two dislocations on intersecting glide planes with Burgers vectors at 120°. The observations provide direct evidence for the occurrence of pencil glide in which slip can occur on any plane containing a $\langle 110 \rangle$ lattice vector.

3671 CLASSICAL NON-LINEAR LATTICE STATICS OF EDGE DISLOCATIONS. II. CALCULATION. F.Wahl.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 983-93 (Nov., 1960). In German.

Calculations, based on previous work (Abstr. 17921 of 1960), are made of the excitation energy and lattice positions associated with edge dislocations in KCl crystals. J.W.Leech

3672 OBSERVATIONS OF LATTICE DEFECTS IN GRAPHITE BY MOIRÉ PATTERNS. K.Izui.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1829-30 (Dec., 1959).

Two irregularities have been observed in the moiré patterns produced in the electron microscopical image of overlapping crystals in natural graphite. The first effect is ascribed to a rotation of part of one crystal by 10^{-2} radians about the c-axis, and the second effect to lattice defects. A detailed discussion will appear elsewhere. V.E.Cosslett

3673 DISLOCATIONS IN NON-METALLIC LAYER STRUCTURES. J.R.Bristow and B.L.Rees.
Nature (GB), Vol. 188, 44 (Oct. 1, 1960).

It is pointed out that in addition to the hexagonal network of dislocations observed by Amelinckx and Delavignette (Abstr. 7886 of 1960), grids of crossing dislocations in talc and mica are revealed by transmission electron microscopy. R.F.Peart

3674 DIRECT EVIDENCE FOR THE PRESENCE OF QUARTER-DISLOCATIONS IN TALC MONOCRYSTALS. S.Amelinckx and P.Delavignette.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 533-5 (May, 1960).

Thin cleavage foils of talc monocrystals were examined in transmission electron microscopy using the techniques developed by Hirsch et al. (Abstr. 21256 of 1960; 970 of 1961) and direct evidence is produced for the existence of quarter-dislocations in this material. It is further suggested that such quarter-dislocations may also exist in the related clay minerals. R.Bullough

3675 DEVELOPMENT OF DISLOCATIONS AND SOME FORMS OF ETCH FIGURES IN SILICON SINGLE CRYSTALS. N.N.Sirota and A.A.Tonoyan.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 6, 1397-8 (Oct. 21, 1960). In Russian.

Silicon plates lying mostly near to the (111) plane were etched (a) in a mixture of HF, HNO_3 and acetic acid and (b) in a boiling 20% KOH solution. The etch figures were of spiral, terraced and triangular form. They are described and reproduced photographically. Some microhardness measurements are also reported. [English translation in: Soviet Physics – Doklady (USA)]. R.F.S.Hearmon

3676 ETCH PITS AT DISLOCATIONS IN COPPER. F.W.Young, Jr.
J. appl. Phys. (USA), Vol. 32, No. 2, 192-201 (Feb., 1961).

A possible mechanism for the development of etch pits at dislocations in copper by etching in solution is presented, and experiments are described which may substantiate this mechanism. Etchants which will develop pits at clean dislocations on the (111), (100), and (110) faces of copper are described. These etchants are capable of distinguishing between clean dislocations and dislocations with a "Cottrell atmosphere" in 99.999% copper. Clean edge and screw dislocations can also be differentiated with these etchants. Some observations concerning the relation of facet structure, developed by etching, to the dislocation structure of the crystal are reported.

3677 THE DECORATION OF DEFECTS IN SILVER CHLORIDE CRYSTALS. M.P.Shaskol'skaya and A.A.Blistanov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2270-5 (Sept., 1960). In Russian.

Experiments are described in which zinc is brought into contact with AgCl crystals, producing reduction to silver in regions of high defect concentration; these regions are made visible by

iridescent coloration. The reduction takes place both on the surface and within the crystals, and becomes more active at higher temperatures. [English translation in: Soviet Physics–Solid State (USA)].
R.F.S.Hearmon

3678 EVIDENCE FOR THE PRODUCTION OF DEBRIS BY MOVING DISLOCATIONS IN SODIUM CHLORIDE.
R.W.Davidge and R.W.Whitworth.
Phil. Mag. (GB), Vol. 6, 217-24 (Feb., 1961).

Several kinds of etch pit are formed when NaCl is etched with a mixture of acetic acid and methyl alcohol. In particular, slip bands contain shallow pointed pits in addition to the normal pits formed at dislocations. The density of these shallow pits is reduced by an anneal at around 300° C before etching, and it is believed that they originate at "debris" left behind moving dislocations. Debris is also produced by the to-and-fro motion of edge and screw dislocations in crystals vibrated at high amplitudes at 90 kc/s, and this effect is related to a decrease in the internal friction. Experiments on LiF show that three etches which reveal dislocations differ in the extent to which they also reveal debris.

3679 ROOM-TEMPERATURE DISLOCATION DECORATION INSIDE LARGE CRYSTALS. C.B.Childs and L.Slifkin.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 502-3 (Dec. 1, 1960).

Moderate print-out Ag densities were produced in single crystals of AgCl by the Haynes–Shockley method, and after several days of room temperature ageing, sharply decorated dislocations were observed by ordinary bright-field microscopy. Continuous examination throughout the interior of the crystals revealed, in addition to dislocation networks, other structures such as pure tilt boundaries.
R.F.Peart

Diffusion

3680 METHODS OF CALCULATING THE MOBILITY OF IMPURITY IONS IN SOLID BODIES. R.Sh.Malkovich.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2784-94 (Nov., 1960). In Russian.

Since the Einstein formula for the ratio of the mobility to the diffusion constant is not always applicable, methods of measuring this ratio are required. Some simple situations are described in which it can be determined without solving the transport equations. In one case, the source of impurity ions must be sharp and the concentration of ions must be zero on both boundaries, or the concentration should be zero on one boundary and the source should be located on the other. The boundary conditions can be relaxed for infinite bodies. For infinite bodies, a simpler method of calculating the mobility is also described. Some other special cases are treated. [English translation in: Soviet Physics–Solid State (USA)].
D.J.Thouless

3681 MOVEMENT OF DEFECT CENTRES IN CRYSTALS WITH PARTIAL CONSIDERATION OF ELECTROSTATIC INTERACTION. A.Scholz.
Z. Phys. (Germany), Vol. 161, No. 3, 267-78 (1961). In German.

The potential energy of the interaction between defects is introduced in expressions for the transition probability frequencies of mobile defects. Hence the diffusion equation for the defects contains both drift and diffusion terms, and a rough estimate can be made of the average drift time of a mobile defect towards a fixed defect. The drift time is taken to be the reaction time for the production of defect centre associations. The reaction times for silver halides are calculated; the activation energy of a Br vacancy in AgBr is estimated to be between 0.55 and 0.75 eV.
J.Franks

DIFFUSION IN HOMOPOLAR SEMICONDUCTORS.
See Abstr. 3739

3682 THE THERMAL DIFFUSION OF CARBON IN α AND γ IRON. P.Shewmon.
Acta metallurgica (Internat.), Vol. 8, No. 9, 605-11 (Sept., 1960).

The heats of transport, Q^* for carbon in α and γ iron were accurately measured. A radioactive tracer technique was used and the following values obtained. $Q_C^*(\alpha) = -24 \pm 1.5$ kcal at 700° C, $Q_C^*(\gamma)$ ranged from −2 kcal to zero in going from 0.02% to 0.92% C at approximately 940° C. A kinetic treatment due to Wirtz explains the data for $Q_C^*(\alpha)$ if it is assumed that all of the activation energy for carbon diffusion goes into preparing the lattice around the site the atom jumps into. From this satisfactory explanation of Q^* it would appear that studying the effect of a temperature gradient on other simple diffusion systems would give information on the spacial distribution of the activation energy which is required before an atom can change position.

3683 EFFECT OF GRAIN SIZE ON THE DIFFUSION OF CARBON IN IRON.
I.E.Kontorovich and Yu.M.Mermel'shtein.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 5, 812–18 (1958). In Russian.

The following conclusions are reached: (1) C diffusion increases with increasing grain size; (2) depending on the grain size, the depth of the diffused layer can increase by 200–250%; (3) C concentration in the surface layers is greater in fine-grained than in coarse-grained Fe; (4) plastic deformation promotes an increase both in amount of C absorbed and in diffusion depth. Recrystallization after deformation reduces the diffusion depth. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 5, 40–5 (1958)].

3684 DIFFUSION OF Cu INTO CdS SINGLE CRYSTALS THROUGH DISLOCATIONS. S.Ibuki and H.Yamashita.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1827 (Dec., 1959).

Preliminary experiments on the diffusion of Cu in Cl-doped CdS crystals at 300° C in air, suggests that dislocations have a greater influence on diffusion under an electric field than on thermal diffusion.
R.F.Peart

3685 DIFFUSION COEFFICIENTS OF HELIUM IN FUSED QUARTZ. D.E.Swets, R.W.Lee and R.C.Frank.
J. chem. Phys. (USA), Vol. 34, No. 1, 17-22 (Jan., 1961).

The diffusion of helium through the walls of high-purity fused quartz hollow cylinders was studied using a mass spectrometer as a detecting device. By surrounding the outside of the hollow cylinder with helium and observing it diffuse through into the mass spectrometer, permeation rates and diffusion coefficients were measured in the temperature range of 24° to 1034° C. The diffusion process appeared to be relatively simple with only small deviations from Fick's laws occurring. The activation energy was found to be different in the temperature range of 24° to 300° C than in the range of 300° to 1034° C. In the low-temperature range the diffusion coefficients are expressed by

$$D = 3.04 \times 10^{-4} \exp\left(-\frac{5580 \pm 56 \text{ cal/g atom}}{RT}\right) \text{cm}^2/\text{sec},$$

and in the high-temperature range they are expressed by

$$D = 7.40 \times 10^{-4} \exp\left(-\frac{6613 \pm 40 \text{ cal/g atom}}{RT}\right) \text{cm}^2/\text{sec}.$$

The solubility was also determined by dividing the permeability by the diffusion coefficients. This was expressed by

$$S = 1.99 \times 10^{17} \exp\left(-\frac{-680 \pm 60 \text{ cal/g atom}}{RT}\right) \text{atoms/cm}^3$$

in the temperature range of 24° to 300° C and by

$$S = 1.28 \times 10^{17} \exp\left(-\frac{-1174 \pm 120 \text{ cal/g atom}}{RT}\right) \text{atoms/cm}^3$$

in the range 300° to 1034° C.

3686 MICROGRAPHICAL STUDY OF THE DIFFUSION OF MAGNESIUM IN CATHODE NICKEL. H.Provisor.
Vide (France), Vol. 15, 151-79 (March-April, 1960). In English and French.

The effects produced by the diffusion of magnesium in cathode nickel on heating in a humid reducing atmosphere were studied, with a view to improving the method of forecasting the electronic behaviour of magnesium-activated cathode nickel in strip, semi-finished or sleeve form. The test pieces were heated at 1100° C in damp cracked ammonia or damp hydrogen for periods varying from 20 min to 9 hr. It was found that a photomicrograph of the surface, taken in polarized light or normal light after the test piece has been heated for 20 min to 1 hr, furnished an "identification photograph" of the test-piece with reference to the diffusion of magnesium. Such a photograph is particularly sensitive to the "free" magnesium content of the test piece and, to a certain extent, to the history of its formation. It is proposed that such a photomicrograph should serve as a simple criterion for appraising the probable electronic characteristics of the test piece. After photomicrographs of the surface of a number of specimens had shown that the diffusion of magnesium takes place basically via the boundaries between grains, the

explanation of this fact was sought by examining the interior of a test piece coated with barium strontium carbonate, and treated under vacuum, as with a cathode. An oblique section, together with measurements of microhardness, demonstrated a Kirkendall effect which affected the boundaries between grains in particular, and accentuated their property of constituting a preferred migration path for the magnesium. In addition, the oblique section permits the measurement of the depth of the diffusion zone, which is a quantity capable of characterising either the alloy itself or a particular process.

3687 DISTRIBUTION OF PHOSPHORUS ATOMS DURING DIFFUSION IN SILICON.
V.K.Subashiev, A.P.Landsman and A.A.Kukharskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2703-9 (Nov., 1960). In Russian.

Reports measurements of variation of the phosphorus atom distribution with depth. The distribution differed from that predicted by the second Fick law. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3688 DIFFUSION, SOLUBILITY, AND THE INFLUENCE OF ADMIXTURES OF SILVER UPON THE ELECTRICAL PROPERTIES OF SILICON.
B.I.Boltaks and Syué Shi-in' [Hsüeh Shih-yin] .
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2677-84 (Nov., 1960). In Russian.

The diffusion coefficient for the diffusion of silver into silicon was measured for various temperatures in the interval 1100-1350° C, and was found to be exponential in character. The method used the radioactive Ag^{110} as a tracer. This was also used in an experiment to investigate the solubility of silver in silicon in the temperature range 1200-1390° C. From an investigation of the temperature variation of the specific resistance of silver doped n- and p-type silicon, the position of the energy levels of the silver in the two cases was found. Results are also given of measurements of the variation of the number of carriers and of specific resistance with the concentration of the dissolved silver. Calculated and experimental values of these quantities are compared in a table. [English translation in: Soviet Physics—Solid State (USA)]. K.G.Major

3689 DIFFUSION OF SILVER IN PLASTICALLY DEFORMED COPPER. L.M.Shestopalov and Yu.Romashkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 2998-3008 (Dec., 1960).

Silver diffused in coarse-grained copper which was deformed (creep) at rates from 0 to 2000% per hr. At 600° C the diffusion coefficient D varied linearly with the rate of deformation e (in % per hr): $(D/D_0) = 1 + Ke$, where $K = 0.011$. With increase of the rate of deformation, the rate of diffusion decreased. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3690 SULFUR SEGREGATION AT α-IRON GRAIN BOUNDARIES. I. N.G.Ainslie, R.E.Hoffman and A.U.Seybolt.
Acta metallurgica (Internat), Vol. 8, No. 8, 523-7 (Aug., 1960).

Radioactive sulphur was introduced simultaneously into single crystal and polycrystal specimens of high purity α-iron by reaction with H_2S. After lengthy annealing and rapid quenching, the polycrystals are found to contain 50-100% more sulphur than the single crystals, and the excess sulphur in the polycrystals is found to be concentrated at the grain boundaries. All available evidence indicates that the sulphur was in solid solution at the equilibration temperature, although the amount of sulphur segregated at the boundaries is much greater than can be accounted for on the basis of equilibrium adsorption.

3691 SULFUR SEGREGATION AT α-IRON GRAIN BOUNDARIES. II. N.G.Ainslie, V.A.Phillips and D.Turnbull.
Acta metallurgica (Internat), Vol. 8, No. 8, 528-38 (Aug., 1960).

Alpha iron grain boundaries containing large excesses of adsorbed sulphur were examined using transmission electron microscopy. The study revealed that the grain boundaries of the sulphurized iron were commonly associated with very high density dislocation networks that could extend several microns into the bodies of the grains. The dense networks were not observed in pure, sulphur-free iron. The networks are thought to form when the sulphur, having first entered the specimens by preferential diffusion along grain boundaries, diffuses from the grain boundaries laterally into the grains. The sulphur, which diffuses in iron as a substitutional element about 30 times faster than iron self-diffuses, establishes a diverging vacancy flux toward the boundaries. The result, is a vacancy undersaturation in the neighborhood of the boundaries that accounts, it is believed, for the high dislocation density; the vacancy undersaturation causes dislocation multiplication by "down-climb". The abnormal segregation of sulphur in the vicinity of α-iron grain boundaries is explained if it is assumed that sulphur is adsorbed by dislocations in the boundary networks. The possible effects of these grain boundary networks on certain other metallurgical phenomena are considered.

3692 EFFECT OF STATIC STRAINS ON DIFFUSION. L.A.Girifalco and H.H.Grimes.
Phys. Rev. (USA), Vol. 121, No. 4, 982-91 (Feb. 15, 1961).

A theory is developed that gives the diffusion coefficient in strained systems as an exponential function of the strain. This theory starts with the statistical theory of the atomic jump frequency as developed by Vineyard [J. Phys. Chem. Solids (GB), Vol. 3, 121 (1957)]. The parameter determining the effect of strain on diffusion is related to the changes in the interatomic forces with strain. Comparison of the theory with published experimental results for the effect of pressure on diffusion shows that the experiments agree with the form of the theoretical equation in all cases within experimental error.

Colour Centres

3693 BLEACHING AND RECOVERY OF F CENTERS IN KCl. L.E.Silverman and L.I.Grossweiner.
Phys. Rev. (USA), Vol. 121, No. 4, 1072-5 (Feb. 15, 1961).

F-centres in KCl are optically bleached at room temperature with a minimum light energy of 20.1 ± 1.0 eV per F-centre. The F-band is recovered on further room-temperature X-ray irradiation with a minimum energy of 69 ± 5 eV per F-centre. The increase in the M- and R-bands during optical bleaching of the F-band is nullified upon the recovery of the F-band by further X-ray irradiation. The recovery kinetics are of second order in the number of optically bleached F-centres with a rate-constant of $(7.9 \pm 0.8) \times \times 10^{-20}$ cm^3/F-centre sec. The rate law requires an energy transfer from the bulk lattice and is consistent with an exciton mechanism.

3694 Z-CENTRES IN SODIUM CHLORIDE CONTAINING CALCIUM. J.E.Caffyn and B.K.Ridley.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 153-64 (Jan., 1961).

The optical absorption of single crystals of sodium chloride containing calcium as impurity was measured. Results are given which show a new band at 345 mμ. From measurements of the bandwidth of the F-band it is deduced that a Z_1-band is present in specimens, X-ray coloured, at room temperature. The growth of the Z-bands on bleaching in samples containing differing amounts of calcium impurity and the effect of quenching were also studied. Rate equations are used to discuss the coloration of NaCl and are also applied to the complex (Ca^{2+} . ⊞ . 2⊞⊟) to explain the coloration of the crystals containing Ca^{2+}.

Radiation Effects

3695 ENERGY DEPENDENCE OF RADIATION DAMAGE IN TUNGSTEN. D.R.Muss and J.R.Townsend.
J. appl. Phys. (USA), Vol. 32, No. 2, 189-92 (Feb., 1961).

The rate of radiation damage is shown experimentally to depend on the energy of the incident deuterons almost as 1/E. The small deviation from the 1/E dependence is in a direction opposite to that predicted by the hard-sphere model for secondary defect production.

3696 THE DEPENDENCE OF THE NUMBER OF RADIATION DEFECTS IN SILICON ON THE INITIAL ELECTRON ENERGY. B.Ya.Yurkov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2710-12 (Nov., 1960). In Russian.

Tabulates radiation defect numbers for initial electron energies from 0.15 to 0.7 MeV, taking E_{min} for a displacement defect as 0.145 MeV (Abstr. 2943 of 1959). The linear region of higher energies extrapolates to an apparent E_{min} of 0.28 MeV. The existing experimental results for low energies show too much scatter for a quantitative comparison with this theory. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

3697 HIGH-ENERGY RADIATION DAMAGE TO FLUORESCENT ORGANIC SOLIDS. C.F.Sharn.
J. chem. Phys. (USA), Vol. 34, No. 1, 240-6 (Jan., 1961).

Radiation damage to organic solids exposed to Co^{60} gamma-rays is studied through the analysis of the induced fluorescent changes. From the fluorescence degradation for two series of aromatic hydrocarbons, correlations between chemical structure and radiation damage are established. In addition, modifications in a conventional model used to describe the fluorescent degradation mechanism in organic materials are suggested by the data. Some of the organic materials studies have potential application in a dosimetry system based on fluorescence degradation.

3698 THE INFLUENCE OF NEUTRON IRRADIATION ON CRYSTAL FINE STRUCTURE AND THE PROPERTIES OF METALS AND ALLOYS.
I.V.Batenin, V.A.Il'ina, V.K.Kritskaya, G.V.Kurdyumov and B.V.Sharov.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 4, 802-5 (Oct. 1, 1960). In Russian.

Annealed samples of copper, iron, and a series of iron alloys were irradiated with 10^{21} neutrons/cm^2. Half-widths of X-ray lines were found to have increased by 20 for the pure metals but there was little change for the alloys. Microhardness was also measured as a function of cold plastic deformation both before and after irradiation. The change in half-width for the pure metals is interpreted as a reduction in the size of the region of coherent scattering and the appearance of microstresses within grains, while the considerable increase in hardness of the alloys is ascribed to an increase in the resistance to dislocation movement. For pure iron the increase in hardness due to irradiation was almost independent of deformation but for iron + 0.6% tungsten the increase in hardness decreased considerably with increasing deformation.
M.G.Priestley

3699 DAMAGE IN UO_2 FILMS AND PARTICLES DURING REACTOR IRRADIATION. T.K.Bierlein and B.Mastel.
J. appl. Phys. (USA), Vol. 31, No. 12, 2314-15 (Dec., 1960).

Exposures in the range from 10^{16} - 5×10^{19} n.v.t. were made with 100A thick films on a carbon base, and 1-2 μ diameter particles in an aluminium film. Damage due to fission tracks was examined in an electron microscope and by electron diffraction. Extensive damage was apparent above $\sim 10^{18}$ n.v.t., the nature of it depending on whether the exposure was in air or in vacuum. The particles showed less damage but the effects were apparent in air above $\sim 10^{19}$ n.v.t.
A.Ashmore

3700 FISSION FRAGMENT DAMAGE IN NONFISSIONABLE THIN FILMS. T.K.Bierlein and B.Mastel.
J. appl. Phys. (USA), Vol. 31, No. 12, 2315-16 (Dec., 1960).

Multilayered films were prepared using shadow-casting at 15° to obtain regions with and without UO_2. After an exposure of 2×10^{16} n.v.t. both Pt and ZrO_2 showed fission fragment tracks under the electron microscope in regions containing no UO_2. The formation of the tracks is discussed.
A.Ashmore

3701 RADIATION DAMAGE IN GRAPHITE. G.E.Bacon.
J. Chim. phys. (France), Vol. 57, No. 10, 829-36 (Oct., 1960).

A review of the contribution made by X-ray crystallographic studies to the understanding of the nature of changes in graphite induced by neutron bombardment. Changes in bulk density, stored energy, thermal conductivity and hardness are noted. An account is given of the application of X-ray methods to the analysis of line breadths and line shapes, using Fourier analysis; to the determination of changes in unit cell dimensions; and to the study of small-angle scattering.
J.Thewlis

3702 THE EFFECTS OF NEUTRON BOMBARDMENT ON LITHIUM FLUORIDE CRYSTALS.
E.V.Kolontsova and M.I.Zhestovskaya.
Kristallografiya (USSR), Vol. 5, No. 1, 56-62 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 48-53 (July-Aug., 1960).

Selective etching and X-ray diffuse scattering were used to examine LiF crystals given doses ranging from 7.8×10^{17} to 5×10^{18} n/cm^2. The crystals split up into fragments bounded by planes of the (100) type, and regions differing in orientation from the parent crystal are produced.

3703 DIFFUSE X-RAY SCATTERING FROM IRRADIATED DIAMOND, SAPPHIRE, SILICON AND GERMANIUM CRYSTALS. S.T.Konobeevskii and F.P.Butra.
Atomnaya Energiya (USSR), Vol. 5, 572 (1958). In Russian.

A report of measurements on the changes on the unit cell in diamond, sapphire, silicon and germanium crystals after being subjected to irradiation by fast neutrons in a reactor. Annealing experiments showed that the initial increase in unit cell size tended to be lost after annealing in diamond. Seven and half hours annealing at 500° C produced 55% recovery. Ultimately 79% recovery was secured, but complete recovery was not achieved. The diffuse scattering due to neutron irradiation of sapphire and silicon disappeared completely after annealing. Changes in unit cell size and diffuse scattering were not observed in irradiated germanium. [English translation in: Reactor Science (GB), Vol. 11, No. 1, 48 (Nov., 1959)].
S.Tolansky

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

3704 THE INFLUENCE OF SURFACES ON THE ELECTRICAL CONDUCTIVITY OF SOLIDS AT ELEVATED TEMPERATURES. J.Mertsching.
Ann. Phys. (Germany), Vol. 7, No. 3-4, 123-39 (1961). In German.

It is shown that, under certain circumstances, the relaxation time for the electron–lattice interaction is independent of the surface. The latter is treated in the collision term of a Boltzmann equation along the lines adopted in the discussion of lattice defects.
P.T.Landsberg

3705 QUANTUM THEORY OF THE ELECTRICAL CONDUCTIVITY OF METALS IN STRONG MAGNETIC FIELDS. Yu.A.Bychkov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 689-702 (Sept., 1960). In Russian.

Magnetoelectric effects in strong magnetic fields at very low temperatures are analysed by quantum mechanics in the limiting case when the lifetime of a free electron considerably exceeds its period of revolution in the magnetic field. Metals with a quadratic dispersion law are investigated. Formulae are obtained for scattering of an electron on an impurity in the presence of a magnetic field. [English translation in: Soviet Physics–JETP (USA)].

3706 THEORY OF ELECTRICAL CONDUCTIVITY OF ANTIFERROMAGNETIC METALS [BASED ON AN s–d EXCHANGE MODEL]. Yu.P.Irkhin.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 586-9 (1958). In Russian.

[English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 4, 9-12 (1958)].

3707 SOME REGULARITIES OF THE ELECTRICAL PROPERTIES OF THE BORIDES, CARBIDES AND NITRIDES OF THE TRANSITION METALS OF GROUPS IV-VI OF THE PERIODIC SYSTEM.
S.N.L'vov, V.F.Nemchenko and G.V.Samsonov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 577-80 (Nov. 21, 1960). In Russian.

The Hall coefficient (R), resistivity (ρ) and thermoelectric power of many of the borides, carbides and nitrides of Ti, V, Cr, Zr, Nb, Mo, Hf, Ta and W were measured. Several regularities were noted and it was deduced that the electron mobility in the group IV diborides is very much larger than in the corresponding metals. This is attributed to a reduction of electron scattering by the metal atoms and a broadening of the conductivity band. In the carbides only the latter process is effective while in the nitrides the d-band is broadened causing increased hole mobility. During the transition from groups IV-V-VI, the hole contribution to the conductivity increases. It is concluded that the electron structure of both the metal and metalloid atoms have a large influence on the electrical properties of the compounds. [English translation in: Soviet Physics–Doklady (USA)].
D.J.Huntley

3708 STRUCTURE AND PROPERTIES OF THE HgTe–CdTe SYSTEM. A.D.Shneider and I.V.Gavrishchak.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2079-81 (Sept., 1960). In Russian.

HgTe and CdTe were fused together to form HgTe–CdTe solid solutions with electrical conductivities ranging from 10^3 (pure HgTe) to 10^{-4} ohm^{-1} cm^{-1} (pure CdTe). Samples with 65 and 75 mol.% CdTe exhibited photovoltaic and photoconductive effects; in pure CdTe only photoconductivity was observed. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3709 ELECTRICAL CONDUCTIVITY OF TRANSITION METAL SILICIDES. V.S.Neshpor and G.V.Samsonov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2202-9 (Sept., 1960). In Russian.

Measurements of the electrical conductivity and the Hall effect showed that the majority of these compounds have metallic conduction, with the exception of barium, chromium, iron, rhenium, and manganese disilicides ($MeSi_2$) which are semiconductors. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3710 RESISTIVITY OF THIN METALLIC WIRES. F.J.Blatt and H.G.Satz.
Helv. phys. Acta (Switzerland), Vol. 33, No. 9, 1007-20 (1960).

Measurements by Olsen (Abstr. 11055 of 1959) on thin indium wires have demonstrated that not only the residual but also the temperature dependent part of the resistivity increases with decreasing wire diameter. It was suggested by Olsen that small-angle electron–phonon scattering may account for the observed effect by scattering electrons to the surface where they suffer diffuse reflection. Since an exact solution of the transport equation, taking account of such phonon-surface scattering events, is beset with mathematical difficulties the problem is considered using basically the same elementary approach as employed by Nordheim (1931). It is found that Olsen's mechanism leads to an additional resistivity given by

$$\rho_{ps} = (2\pi)^{1/3}(mv_F/ne^2)^{2/3}(T/\theta_D)^{2/3}[\rho_i^N(T)]^{1/3}(r)^{-2/3};\ r \ll l.$$

Here v_F is the velocity at the Fermi energy and $\rho_i^N(T)$ is the ideal resistivity due to normal phonon scattering only. This expression is valid only if r, the wire radius, is less than the electron mean free path, l, in the bulk material. The above expression is in reasonable agreement, qualitatively and quantitatively, with Olsen's results and, within the range of validity, also accounts for Andrew's observations (Abstr. 1901 of 1949). It is suggested that careful measurements on thin wires may allow an experimental separation at low temperatures between the ideal resistivities due to normal and to umklapp processes.

3711 ELECTRICAL RESISTIVITIES OF [NICKEL-RICH] NICKEL–NIOBIUM SOLID SOLUTIONS. S.Arajs.
J. appl. Phys. (USA), Vol. 32, No. 1, 97-9 (Jan., 1961).

The resistivities were determined from liquid helium temperatures to 1000° K. The Matthiessen rule is not obeyed at any temperature. The addition of niobium to nickel increases its ideal electrical resistivity when the alloy is in the ferromagnetic state but decreases it in the paramagnetic region. Dissolved niobium in nickel at liquid helium temperatures causes considerably larger perturbation for the conduction electron transport than either copper or palladium.

3712 CONTRIBUTION TO THE EXPERIMENTAL STUDY OF THE ELECTRICAL CONDUCTIVITY OF THIN FILMS OF GOLD. S.Minn.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 51, 131-60 (June, 1960). In French.

The resistivity was studied as a function of thickness for films on three different substrates. At a particular thickness the layer losses its granular nature and becomes continuous, and the transition occurs at 35 A when the substrate is bismuth oxide, 70 A for glass and 90 A for magnesium fluoride. Measurements were made of the condensation coefficient and the latent heat of condensation. The temperature coefficient of resistivity was measured from 185° K to room temperature. For the thin granular films the resistance-temperature relation is similar to that of thermionic emission, but in the thicker films, when the distance between the grains is small, effects are observed which may be due to tunnelling. C.Hilsum

3713 THE ELECTRICAL RESISTIVITY OF MONOCRYSTALLINE AND LIQUID BISMUTH.
D.T.J.Hurle and S.Weintroub.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 163-5 (July, 1960).

Experimental results are reported for zone-refined bismuth rods accurately $\frac{1}{4}$ in. in diameter and approximately 5 in. long. The rods contained impurities of the order of 7 p.p.m. The variation of resistivity ρ with temperature t° C is shown graphically for the range 20° to 300° C (melting point 271.0° C) for five single crystals of orientations $\psi = 7°$ to 85°, where ψ is the angle between the rod and trigonal axes. Values of ρ for $\psi = 0°$ and 90° were deduced and are tabulated. The ratios of ρ(liquid)/ρ(solid) at the melting point was 0.349 ± 0.005 and 0.467 ± 0.007 for $\psi = 0°$ and 90° respectively. No indications of any phase anomalies or anticipation of melting were observed. S.Weintroub

ELECTRICAL CONDUCTIVITY OF Si–Cr ALLOYS. See Abstr. 3797

3714 HALL EFFECT AND RESISTANCE IN THE IRON–COBALT SERIES. W.Jellinghaus and M.P.de Andrés.
Ann. Phys. (Germany), Vol. 7, No. 3-4, 149-58 (1961). In German.

Maximum values of electrical resistivity, ordinary and extraordinary Hall coefficients in pure iron–cobalt alloys were found at compositions of approximately 18% Co. The decrease in resistivity with greater cobalt content is very rapid; the ordinary and extraordinary Hall coefficients become negative with cobalt concentrations in excess of 27% and 32%, respectively. Above 30%, Co electron conduction appears to be dominant. R.Parker

3715 GALVANOMAGNETIC EFFECTS AND THEIR APPLICATION. C.Hilsum.
Brit. J. appl. Phys., Vol. 12, No. 3, 85-91 (March, 1961).

The simple theory of Hall effect and magnetoresistance is discussed. The use of various semiconductors for galvanomagnetic applications is considered, and some practical applications are described.

3716 A STUDY OF THE HALL EFFECT IN SILICIDES OF THE TRANSITION METALS.
V.S.Neshpor and G.V.Samsonov.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 6, 1337-8 (Oct. 21, 1960). In Russian.

Hall coefficients were measured for silicides of metals of groups IV-VIII. The majority behave as metals and have a characteristic carrier concentration of 10^{22} to 10^{23} cm^{-3}, except the disilicides of rhenium and chromium which are impurity semiconductors at room temperature. It is found that metals of high atomic number tend to produce predominantly hole conduction (i.e. a positive Hall constant). Some silicides of Ni, Co, Fe, Mn were found to be ferromagnetic. [English translation in: Soviet Physics–Doklady (USA)]. M.G.Priestley

3717 THE ANISOTROPY OF THE HALL EFFECT IN TIN. V.N.Kachinskii.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 4, 818-21 (Dec. 1, 1960). In Russian.

The anisotropy was measured at 4.2° K in single crystals with resistance ratios of between 5 and 60 × 10^3. Magnetic fields of up to 7 kG were used. A superconducting modulator was used to increase sensitivity. Several rotation diagrams are given and in each case the Hall field shows a deep minimum when the magnetic field lies along [100] or [110]. [English translation in: Soviet Physics–Doklady (USA)]. M.G.Priestley

3718 ON THE ISOTROPIC AND ANISOTROPIC COMPONENTS OF THE EVEN PHOTOMAGNETIC EFFECT. I.K.Kikoin and S.D.Lazarev.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1371-3 (Dec. 21, 1960). In Russian.

Experiments on the even photomagnetic e.m.f. are analysed, and separation of the isotropic and anisotropic components is carried out on the basis of a phenomenological theory developed elsewhere (Abstr. 9641 of 1959). It is found that the two components of the even photomagnetic e.m.f. depend differently upon the magnetic field, and can differ in sign. [English translation in: Soviet Physics–Doklady (USA)].

3719 HALL EFFECT IN ALLOYS IN THE REGION OF THE FERROMAGNETIC TRANSITION.
K.P.Belov, E.P.Svirina and Yu.V.Belous.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 621-7 (1958). In Russian.

The Hall e.m.f. in Invars was measured in the region of the Curie point, as a function of magnetization. From the results of the measurements, the Hall effect, accompanying spontaneous magnetization ("spontaneous" Hall effect), was isolated, and the corresponding Hall constant determined. It is shown that, in the region of the Curie point, the Hall constant is proportional to the square of spontaneous magnetization. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 4, 41-6 (1958)].

3720 EXTRAORDINARY HALL EFFECT IN SILICON–IRON SINGLE CRYSTALS. E.Tatsumoto and T.Okamoto.
J. Phys. Soc. Japan, Vol. 14, No. 7, 975-6 (July, 1959).

Describes experiments which confirm that the extraordinary Hall effect is isotropic. The extraordinary Hall coefficient at room temperature for the 1.23% silicon–iron single crystal was 49.2×10^{-11} volt cm/oersted amp. D.M.Edwards

3721 EFFECTIVE FIELD IN THE ORDINARY HALL EFFECT IN FERROMAGNETICS. E.Tatsumoto and T.Okamoto.
J. Phys. Soc. Japan, Vol. 14, No. 7, 976-7 (July, 1959).

Reports Hall effect measurements on a silicon–iron single crystal strip elastically deformed by different applied tensions. It is inferred that the effective field in the ordinary Hall effect is just the magnetizing field. D.M.Edwards

3722 MEASUREMENTS OF GALVANOMAGNETIC TENSORS OF BISMUTH SINGLE CRYSTALS AT LOW TEMPERATURES. S.Mase and S.Tanuma.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1644-5 (Nov., 1959).

Samples from a large single crystal of zone-refined bismuth were used for measurements from which the galvanomagnetic tensors were deduced. The longitudinal tensors are conspiciously smaller than the transverse tensors; slight misolignment of the magnetic field or potential probes can cause a drastic increase in the magnitude of the longitudinal tensor with the field due to the transverse component. A negative magnets-resistance is possibly attributable to physical imperfections as is part of the anisotropy. The magnitude of the longitudinal tensor in the lowest field (~ 200 Oe) is considerably larger than the respective value in zero field. F.E.Hoare

3723 GALVANOMAGNETIC PROPERTIES OF SEMICONDUCTOR THIN FILMS AND SURFACE LAYERS.
A.Amith.
J.Phys. Chem. Solids (GB), Vol. 14, 271-90 (July, 1960).

The behaviour, under the influence of electric and magnetic fields, of carriers, both in thin films and in the surface space-charge layer of semiconductors, is studied analytically. Particular attention is given to diffuse scattering at the surface. The galvanomagnetic properties are evaluated in terms of normalized parameters for the one-carrier case, and for room temperature Ge in the two-carrier case. Twelve figures show graphically the relationship between the many parameters discussed. The effect of the surface potential is severe and no simple way can be deduced for comparing the behaviour of the various parameters in the thin film case. V.J.Hammond

3724 A NOTE ON THE ELECTROMAGNETIC RESPONSE OF NORMAL METALS. S.Nakajima.
Progr. theor. Phys. (Japan), Vol. 23, No. 4, 694-9 (April, 1960).

The general formalism of the transverse conductivity (Abstr. 19557 of 1960) is applied to the simplest example, i.e., the free electron gas, and shown to result in the same extremely anomalous skin effect as the usual method of Reuter and Sondheimer (Abstr. 1032 of 1949). It is also pointed out that the deficiency from the optical sum rule in this example leads to the Landau diamagnetism as required by the author's general formula.

3725 HALL EFFECT OF QUENCHED CONDENSED FILMS OF THE Sn–Cu SYSTEM. J.Fortmann and W.Buckel.
Z. Phys., Vol. 162, No. 1, 93-104 (1961). In German.

Tin alloys with different contents of copper between 0 and 100 atomic-% are produced by the simultaneous condensation of the two components on to a cooled substrate. The electrical resistance, the transition temperature of superconductivity and the Hall coefficient of the films are measured immediately after condensation, during annealing to about 350°K, and recooling to helium temperatures. The observed properties of such alloys differ considerably from those of the bulk material. A rather high transition temperature of about 7°K is observed for copper contents of more than 8 atomic-%. The high transition temperature disappears in connection with the crystallization of the tin component during annealing. Simultaneously with this change of the transition temperature a sharp decrease of the negative Hall coefficient occurs. The results are discussed with regard to a possible influence of the hole concentration on the superconductivity of tin.

3726 ANISOTROPY OF THE ELECTRICAL RESISTANCE OF Mg AND Pt SINGLE CRYSTALS IN A MAGNETIC FIELD AT 4.2°K. N.E.Alekseevskii and P.Gaidukov.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 6, 1720-2 (June, 1960). In Russian.

The anisotropy relationships were characteristic of metals with open Fermi surfaces. [English translation in: Soviet Physics – JETP (USA), Vol. 11, No. 6, 1242-3 (Dec., 1960)].

3727 THE EFFECTS OF HALOGEN GASES ON THE ELECTRICAL CONDUCTIVITIES OF SILVER BROMIDE AND SILVER CHLORIDE. G.W.Luckey.
Disc. Faraday Soc. (GB), No. 28, 113-21 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). The electrical conductivities and the effects of chlorine on the electrical conductivities of silver chloride crystals were measured at temperatures between 25° and 200°C. The increases in conductivity caused by the chlorine are proportional to the square root of the pressure of chlorine in the range from 10 to 600 mm of mercury, and are consistent with those calculated from the corrosion data of Wagner. The effects of bromine on the electrical conductivities of evaporated films and fused crystals of silver bromide were measured in the same range of temperatures and the rates of attainment of equilibrium were measured with some of the crystals at temperatures below 100°C. The apparent diffusion coefficients calculated from these rates are large when the increases in conductivity caused by bromine are large. The conductivities of the silver bromide crystals can also be increased by placing them in an atmosphere of chlorine and these increases in conductivity are equal to those produced by the same pressure of bromine. However, the increases that are caused by the chlorine are not readily reversible at room temperature. Studies of photoconductivity indicate that the photocurrent efficiency in a vacuum is large when the increase in conductivity caused by a given pressure of halogen is large. When crystals of silver bromide are placed in an atmosphere of chlorine, photoconductivity is caused by light with wavelengths as great as 610 mμ.

3728 ELECTRICAL CONDUCTIVITY OF POLYMERS WITH CONJUGATED BONDS.
E.I.Balabanov, A.A.Berlin, V.P.Parini, V.L. Tal'roze, E.L.Frankevich and M.I.Cherkashin.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 5, 1123-6 (Oct. 11, 1960). In Russian.

The conductivity and its temperature dependence were determined for 23 polymers synthesized by the authors and belonging to the following groups: (1) polymers with acyclic conjugation chain (e.g. polyphenylacetylene), (2) polymers with C_6H_6 rings in the conjugation chain (e.g. polyphenylene) and (3) compounds with non-benzenoid cycles in the conjugation chain (e.g. tetrasalicsyl-ferrocene). In all cases the temperature dependence was $\sigma = \sigma_0 \exp(-E/kT)$, where σ_0 and E are constants which, for different substances, vary within 10^{-12} and 6×10^{51} ohm^{-1} cm^{-1} and within 0.2 and 2.1 eV, respectively; both constants are highly influenced by pre-treatment, but their changes usually compensate each other, this "compensation effect" being found in nearly all examined substances. [English translation in: Soviet Physics–Doklady (USA)]. F.Lachman

3729 MEASUREMENTS OF THE ELECTRICAL RESISTANCE OF IODINE AND BLACK PHOSPHORUS AT PRESSURES UP TO 200 000 ATM. L.F.Vereshchagin and E.V.Zubova.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2776-7 (Nov., 1960). In Russian.

The resistance of iodine and red phosphorus was measured at room temperature and static pressures of up to 200 000 atm. The resistance of iodine fell sharply with increase of pressure,

approaching values typical of metals at about 70 000 atm; the initial resistance was almost completely recovered on removal of the pressure. Red phosphorus was converted irreversibly into black phosphorus at 43 000 atm; this transition was accompanied by a sharp fall of the resistance. On further increase of pressure, the resistance of black phosphorus reached values typical of metals at 110 000 atm; on removal of the pressure, the resistance increased to its initial black-phosphorus value. [English translation in: Soviet Physics--Solid State (USA)]. A.Tybulewicz

3730 A THEORY OF THE UNIDIRECTIONAL CONDUCTION IN ALUMINIUM OXIDE FILMS.
B.M.Tareev and M.M.Lerner.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2487-92 (Oct., 1960). In Russian.

Suggests that a p—n junction is present in an aluminium oxide film during "forming" in a weak electrolyte (e.g. boric acid). Uses the junction hypothesis and its destruction under certain circumstances to explain properties of such a film in the "forming" electrolyte and out of it. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3731 TUNNELING THROUGH THIN INSULATING LAYERS. J.C.Fisher and I.Giaever.
J. appl. Phys. (USA), Vol. 32, No. 2, 172-7 (Feb., 1961).

The resistance of thin aluminium oxide films was measured as a function of the voltage across the film and of the film thickness as calculated from its capacitance. All films showed ohmic behaviour at low voltages, and exponential rise of current at higher voltages, in qualitative agreement with Holm's theoretical calculations for tunnelling through thin vacuum layers. However, the resistance was several orders of magnitude lower than either the bulk value for Al_2O_3 or the calculated value for tunnelling through vacuum. By making use of an effective mass in the oxide equal to about $\frac{1}{9}$ of the electron mass, the calculated values for tunnelling can be brought into line with the experimental results.

3732 ELECTRIC CONDUCTION IN ANTIFERROMAGNETICS. G.L.Sewell.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 985-7 (Dec., 1960).

Gives a qualitative explanation of the anomalous electrical properties of the impure antiferromagnetic oxides NiO and α-Fe_2O_3. The model assumes phonon-activated electron jumps as producing low-mobility electrical conductivity, which increases with temperature and does not yield a Hall effect. P.T.Landsberg

Semiconductors

3733 THIRD CONFERENCE ON THE THEORY OF SEMICONDUCTORS. A.E.Glauberman and I.V.Stasyuk.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 1, 117-30 (May, 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 444-56 (Nov.-Dec., 1960).

Held in L'vov, on 2-9 April, 1959. Eighty-six papers were presented.

3734 ON THE SIMULTANEOUS DETERMINATION OF LIFETIME, DIFFUSIVITY AND SURFACE RECOMBINATION VELOCITY OF INJECTED CARRIERS IN SEMICONDUCTORS BY THE FLYING SPOT METHOD. J.Gyulai.
Acta phys. Hungar., Vol. 12, No. 2, 167-70 (1960).

A mode of analysis of the experimental data obtained by the flying spot method is described, which allows the simultaneous determination of bulk lifetime, ambipolar diffusivity and surface recombination velocity of injected carriers in semiconductors. J.B.Birks

3735 PLASTIC FLOW IN SEMICONDUCTORS AND ITS EFFECTS ON ELECTRICAL PROPERTIES.
P.Haasen and A.Seeger.
"Semiconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 68-114. In German.

Present theoretical and experimental knowledge of plastic deformation in metal and ionic crystals and particularly in diamond-type crystals of group III, IV and V semiconductors and alloys is summarized, with particular emphasis on displacement phenomena, illustrated by numerous microphotographs. The electrical properties, include conductivity, Hall constant and mobility, lifetime of minority carriers, etc. are discussed. A.Landman

3736 DEPARTURES FROM THE IDEAL CHEMICAL AND PHYSICAL STRUCTURE OF A SEMICONDUCTOR CONSIDERED IN RELATION TO CHEMICAL REACTIVITY.
W.B.Pearson and G.A.Wolff.
Disc. Faraday Soc. (GB), No. 28, 142-50 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). Treating semiconductors and similar substances, the paper discusses chemical bonding in the bulk of the crystals and its modification in the surface regions. It seeks to relate these considerations to the observed physical and chemical properties of the substances discussed.

3737 HOMOPHASE AND HETEROPHASE FLUCTUATIONS IN SEMICONDUCTING CRYSTALS. R.E.Burgess.
Disc. Faraday Soc. (GB), No. 28, 151-8 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). Theoretical aspects of statistical fluctuations in semiconducting crystals are discussed. A new approach in terms of energy fluctuations leads to a simple relation between the variance of a quantity in thermal equilibrium and its temperature dependence; applications are made to extrinsic and intrinsic semiconductors and to ferroelectric polarization. An alternative approach is given which is particularly suited to cooperative processes in which the kinetics are controlled by barriers of variable height. Discussion is also given of a different type of cooperative process involving a multiplication process (such as impact ionization); here an analogue of a phase transition can occur with fluctuations becoming very large as the "transition" is approached. Discussion is also given of the influence of non-classical statistics of charge carriers which arise in a degenerate band or in impurity conduction; the fluctuations of carrier density are reduced below the Poisson value in a similar manner to the reduction of the mobility/diffusivity ratio below the Einstein value.

3738 SURFACE CONDUCTIVITY OF SEMICONDUCTORS AND ITS VARIATION BY ADSORPTION, TRANSVERSE ELECTRIC FIELDS AND IRRADIATION. G.Heiland.
Disc. Faraday Soc. (GB), No. 28, 168-82 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). The surface of semiconductors is covered with a space-charge layer, which is caused by intrinsic or adsorbed donors and acceptors. Also chemical reaction and diffusion of defects can produce a surface layer whose conductivity differs greatly from the bulk value. Examples are given for zinc oxide and germanium with oxygen and hydrogen. Information on the energy levels for electrons at the surface can be gathered from systematic variations of the surface conductivity. With zinc oxide three such experiments were carried out: field effect (change of carrier density at the surface due to transverse electric fields), adsorption of oxygen, and irradiation with light or electrons. The results are given as drift mobilities of electrons. A consistent explanation is possible with a surface model containing a set of continuously distributed surface states just below the conduction band. Closely connected with the surface photoconductivity are photodesorption and photolysis. Not only electron transitions but also ion migrations are involved in these cases. Examples are given for zinc oxide and the sulphides of zinc and cadmium.

3739 DIFFUSION IN HOMOPOLAR SEMICONDUCTORS. F.M.Smits.
Ergeb. exakt. Naturwiss. (Germany), Vol. 31, 167-219 (1959). In German.

Review article.

3740 AN EXPERIMENTAL CHECK OF THE POSSIBILITY OF INTRODUCTION OF A UNIVERSAL SURFACE RECOMBINATION VELOCITY BY INVESTIGATION OF KINETIC PHOTOELECTRIC PROCESSES. É.I.Rashba.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2693-5 (Nov., 1960). In Russian.

It is shown that, if the surface recombination velocity is the same for various photoelectric processes, the relation between the complex amplitudes will be a complicated function of the frequency of illumination, but will be independent of the state of the surface. This provides a straightforward experimental check of the postulate. [English translation in: Soviet Physics—Solid State (USA)].

3741 [CARRIER] INJECTION ON THE PASSAGE OF A CURRENT THROUGH AN INHOMOGENEOUS SEMICONDUCTOR. Z.A.Demidenko and K.B Tolpygo.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2753-61 (Nov., 1960). In Russian.

Develops a theory of internal injection of minority carriers (holes) on the passage of a current through an inhomogeneous semiconductor. Distribution of the hole density, and of the electric fields is found as a function of the current, conductivity gradients and carrier lifetimes. The algebraic sum of the potential differences between two closely spaced probes is calculated for the case when currents pass through these probes in opposite directions. This quantity is known as the "volume-gradient e.m.f." and it rises quadratically with the current at low currents and linearly at high currents. The volume-gradient e.m.f. depends on the electrical resistance of the semiconductor, carrier lifetime and conductivity gradients. The importance of contacts in measurements of the volume-gradient e.m.f. is pointed out. The present theory is compared with the experimental results obtained by Baranskii (Abstr. 4588 of 1959; 11690 of 1960). [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3742 SEMICONDUCTOR SURFACE TRANSPORT THEORY. R.F.Greene.
J. Phys. Chem. Solids (GB), Vol. 14, 291-8 (July, 1960).

Reviews the current state of semiconductor surface transport theory, particularly for transport in the thin space-change layer. An outline treatment of the mathematical development is given and related where practicable to experimental results for germanium. C.A.Hogarth

3743 THE ROLE OF ELECTRON–PHONON INTERACTION IN THE IMPURITY CONDUCTION OF SEMICONDUCTORS. Y.Toyozawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 378-80 (Feb., 1960).

At low temperature, provided the impurity concentration n is not too large, the electrical resistance of p-type Ge varies with temperature as $\exp(E/kT)$ and E is, within appreciable ranges, independent of n and of the degree of compensation. The author considers a periodic array of impurities with electrons bound in 1s-states, and suggests that either the band model or the localized model is valid, according to whether the impurity band width is larger or smaller than the shift of the levels due to electron–phonon interaction. The transition between the two cases is rather abrupt. In the localized model, the activation energy for the hopping of an electron from one site to another corresponds to the experimentally observed E and, provided one considers also transverse phonons, the calculated value of E is in reasonable agreement with observations. L.Pincherle

3744 THE SPATIAL AND TIME-FLUCTUATION OF COULOMB ENERGY IN THE LOW CONCENTRATION IMPURITY CONDUCTION. Y.Toyozawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 380-2 (Feb., 1960).

Discusses, on the basis of the model of the preceding abstract, the dependence of the conductivity on the degree of compensation K and why E is independent of n within a fairly wide range of values of K. The essential role is played by the Coulomb interaction E_i between an electron localized at the i-th site and all the charged acceptors and donors, and particularly by the fluctuations in E_i caused by the hopping of electrons from one ionized donor to another. L.Pincherle

3745 THE ELECTRICAL PROPERTIES OF EXTENDED CURRENT PATHS IN SPACE-CHARGE ZONES NEAR THE SURFACES OF SEMICONDUCTORS.
E.Groschwitz, E.Hofmeister and R.Ebhardt.
Z. angew. Phys. (Germany), Vol. 12, No. 12, 544-57 (Dec., 1960). In German.

The origins of currents in surface space-charge layers in semiconductors are critically considered. The mathematical analysis of the current flow is outlined and the results are applied to particular geometrical structures such as alloyed diodes. C.A.Hogarth

3746 RADIATIVE RECOMBINATION IN SEMICONDUCTORS. V.S.Vavilov.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 2, 247-60 (June, 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2 (68), No. 3, 455-64 (May-June, 1959).

A general review covering the period up to 1958. The theory of radiative recombination due to van Roosbroeck and Shockley and its application to various substances are considered, together with experimental methods. Radiative recombination in germanium, silicon and III-V compounds is treated. 37 references. [The statement in the first paragraph that the probability of radiative recombination in InSb and PbS is "near to unity" needs considerable qualification. In equation (4) of the translation read R for P]. P.T.Landsberg

3747 A CONTRIBUTION TO THE THEORY OF EXCITON STATES IN SEMICONDUCTORS. I.P.Dzyub.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 610-15 (Sept., 1960). In Russian.

Exciton states are treated by the Green's function method. Frenkel and Mott exciton spectra are determined for an arbitrary temperature. [English translation in: Soviet Physics—JETP (USA)].

VOIGT EFFECT IN SEMICONDUCTORS. See Abstr. 3819

Semiconducting Materials

3748 HALL EFFECT AND CONDUCTIVITY OF EVAPORATED GERMANIUM FILMS.
F.Eckart and G.Jungk.
Ann. Phys. (Germany), Vol. 7, No. 3-4, 210-15 (1961). In German.

Electrical conductivity and Hall effect of thin films of germanium deposited at 10^{-5} torr on glass substrates at 450°C were measured and showed an independence of starting material, only p-type conduction, and a carrier density of 10^{18}-10^{19} cm^{-3}. The hole mobility was about 10 or 100 times smaller than for the single crystal starting material. The Hall coefficient increased with magnetic field, in contrast to the behaviour of crystalline material. C.A.Hogarth

3749 IMPURITY CONDUCTION IN GERMANIUM AT LOW TEMPERATURES.
B.M.Vul, E.I.Zavaritskaya and L.V.Keldysh.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 6, 1361-3 (Dec. 21, 1960). In Russian.

Current density and Hall coefficient versus field intensity were measured at 4.2, 14, 20.4 and 78°K for p-type indium-doped germanium with acceptor concentration about 10^{14} cm^{-3}. Between the breakdown field (5 V/cm) and four times this, the number of ionized acceptors increases from N_D to N_A. The drift velocities are shown as a function of field at 4.2 and 78°K. At 4.2 the mobility is constant up to E = 5 V/cm, then decreases and is again constant at 1/3.5 of the initial value from 20 to 50 V/cm. This is ascribed to an increase of the Coulomb scattering contribution and can be explained theoretically for suitable choice of the relevant parameters. [English translation in: Soviet Physics—Doklady (USA)]. R.Berman

3750 A STUDY OF TRAPPING AT COPPER ATOMS IN GERMANIUM. S.G.Kalashnikov and A.I.Morozov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2813-20 (Nov., 1960). In Russian.

Trapping in n-type germanium, containing copper, was studied using photoconductivity, the photomagnetic effect, the compensation of these two effects, and direct measurement of diffusion lengths. Trapping was mainly due to triply-charged copper ions. These ions acted both as trapping and recombination centres. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3751 THE ELECTRICAL CONDUCTIVITY OF LITHIUM-DOPED GERMANIUM AT LOW TEMPERATURES.
I.A.Kurova and N.D.Tyapkina.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3103-9 (Dec., 1960). In Russian.

The electrical resistivity, Hall constant, and magnetoresistance of germanium samples containing 2.3×10^{14} - 2.9×10^{15} cm^{-3} lithium were studied as a function of temperature in the liquid

helium range. The ionization energy of lithium was found to be 0.0093 eV. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3752 GERMANIUM SATURATED WITH GALLIUM ANTIMONIDE. J.O.McCaldin and D.B.Wittry.
J. appl. Phys. (USA), Vol. 32, No. 1, 65-9 (Jan., 1961).

Single crystals of Ge saturated with GaSb were prepared by temperature gradient zone melting at 750°C. Electron probe microanalysis indicated 4.83×10^{20} Ga atoms and 2.36×10^{20} Sb atoms cm^{-3} in the saturated material with an estimated error of about 10%. Thus the solubility of Sb is greatly enhanced by the presence of Ga, though the reverse is not true. Hall measurements were in semi-quantitative agreement with the chemical concentration measurements and indicated that carrier mobility is not much affected by the presence of the compensating impurity.

3753 MEASUREMENTS OF SURFACE TRANSPORT PHENOMENA. T.H.Geballe.
J. Phys. Chem. Solids (GB), Vol. 14, 72-4 (July, 1960).

Since the understanding of bulk transport properties in germanium has profited by the use of strain fields, thermal gradients, electric and magnetic fields over a wide range of temperature, the extension of some of these variables to measurements of surface phenomena is considered. In particular, the thermoelectric power, thermomagnetic phenomena and high-field transverse magnetoresistance are examined. W.Bardsley

3754 LOW TEMPERATURE TRANSPORT IN "SPLIT P-GERMANIUM". S.H.Koenig and J.J.Hall.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 550-3 (Dec. 15, 1960).

Under shear stress the valence band of Ge splits at the zone centre into two doubly degenerate bands. Measurements of the conductivity and Hall mobility of p-type Ge at 7°K under large strains ($>10^{-3}$) are reported, from which it is possible to determine the sign, the ratio and the approximate magnitude of the two deformation potentials that describe the change, under shear, of the valence band. It was also verified that, over a limited range, the velocity dependence of the hole–acceptor recombination cross-section is independent of the acceptor ground-state energy. L.Pincherle

3755 CYCLOTRON RESONANCE IN GERMANIUM AND SILICON AND THE EFFECT OF NEGATIVE EFFECTIVE MASSES. Yu.Kagan.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 6, 1854-65 (June, 1960). In Russian.

Cyclotron resonance in semiconductors with degenerate valency bands is considered. The frequency and effective mass spectra are determined for the case when the magnetic field is parallel to the axis [001]. The existence of negative cyclotron frequency branches in germanium and silicon is demonstrated. An expression for the absorbed power is derived by solving the kinetic equation. The problem of negative absorption is analysed. [English translation in: Soviet Physics–JETP (USA), Vol. 11, No. 6, 1333-40 (Dec., 1960)].

3756 ELECTRICAL TRANSPORT OF GOLD IN SILICON. B.I.Boltaks, G.S.Kulikov and R.Sh.Malkovich.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2395-9 (Oct., 1960). In Russian.

Studies of electrical (d.c.) transport of gold in silicon showed that between 1075° and 1280°C gold moved mainly towards the cathode, but above 1280°C motion towards the anode predominated (due to drag by electrons moving towards the anode). Diffusion and solubility of gold in silicon in the absence of external electric fields were also studied. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3757 ELECTRON MOBILITIES AND TUNNELING CURRENTS IN SILICON.
R.A.Logan, J.F.Gilbert and F.A.Trumbore.
J. appl. Phys. (USA), Vol. 32, No. 1, 131-2 (Jan., 1961).

In germanium, for a given resistivity, the carrier-concentration is higher in arsenic-doped samples than in antimony-doped material. Hall effect and tunnelling studies on silicon samples show very little correlation between tunnel current density and specific donor impurity, in contrast to germanium. C.A.Hogarth

3758 MEASUREMENT OF THE MINORITY-CARRIER LIFETIME IN SILICON. A.Świt.
Przeglad Elektron. (Poland), Vol. 1, No. 1, 42-47 (1960). In Polish.

The photoconductive method was used to find $\tau = 25$-36 μsec for p-type silicon of 16 ohm cm resistivity. A.Tybulewicz

3759 IMPURITY CONDUCTION IN SILICON. R.K.Ray and H.Y.Fan.
Phys. Rev. (USA), Vol. 121, No. 3, 768-9 (Feb. 1, 1961).

Impurity conduction at low temperature was investigated for various p- and n-type silicon samples. Emphasis was placed on the study of samples of low impurity concentration where the conduction is attributed to charge exchange between impurity centres which are partially ionized by some compensating impurity. A new method was used to determine the compensation. Donors were added to p-type samples by heat treatment. From changes in the room temperature resistivity and the Hall coefficient in the deionization range, the added compensation and the original compensation were determined. The measurement of various samples gave the dependence of the activation energy of conduction on impurity concentration and degree of compensation. The activation energy was much larger for the Ga- and Al-doped samples than for the B-doped samples of comparable impurity concentration. However, it was found that the high activation energies may be the result of ion-pairing between gallium or aluminium atoms and the compensating impurity in the sample. The conductivities of the various samples may be correlated by an expression of conductivity which involves the impurity concentration and the radius of impurity wave-function. The results are discussed in the light of current theories of impurity conduction.

3760 AN INTERPRETATION OF THE ΔE VALUE [FORBIDDEN BAND WIDTH] IN [SEMICONDUCTORS WITH] ZnS STRUCTURE. O.G.Folberth.
Z. Naturforsch. (Germany), Vol. 15a, No. 5-6, 432-4 (May-June, 1960). In German.

The effect of polarization in $A^{III}B^{V}$ compounds is discussed qualitatively. J.E.Caffyn

3761 THE MAGNITUDE OF THE RECOMBINATION COEFFICIENT IN CdS. E.A.Niekisch.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 7, 308-14. In German.

"Electron processes in solids" conference (see Abstr. 2382 of 1961). The recombination coefficient γ was determined by comparing the temperature dependence of the photocurrent with the distribution of bound states beneath the conduction band. In CdS crystals which had been annealed at about 175°C in the dark and in a vacuum, γ was found to vary between 2×10^{-12} and 7×10^{-12} cm^3 sec^{-1}. In crystals which had been exposed to light a value of 10^{-9} cm^3 sec^{-1} was found. A.J.Fox

3762 ELECTRICALLY STIMULATED CURRENTS IN CdS SINGLE CRYSTALS. S.Kanev.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 7, 238-55. In German.

"Electron processes in solids" conference (see Abstr. 2382 of 1961). CdS crystals were provided with sputtered Au electrodes, which were strongly rectifying. On applying a potential to crystals which had previously been irradiated, an electrically stimulated current flowed, having rapid growth and slower decay characteristics. The variation of the electrically stimulated current with radiation intensity, applied voltage, temperature and waiting time (time between switching off radiation and applying voltage) was obtained. With suitable crystals an effect is detectable with irradiation intensities of a few mR/W. J.Franks

3763 ELECTRONIC PROPERTIES OF PRE-GRAPHITE CARBONS. A.Pacault and A.Marchand.
J. Chim. phys. (France), Vol. 57, No. 10, 873-91 (Oct., 1960). In French.

A review of structural models and of experimental data (and their interpretation) on Hall effect, magnetoresistance, thermoelectric power, magnetic susceptibility and electrical resistance, relating to the numerous compounds intermediate between graphite and polycyclic aromatic systems. L.Pincherle

3764 A STUDY OF THE ELECTRONIC STRUCTURE OF PRE-GRAPHITE CARBONS. A.Pacault, A.Marchand, P.Bothorel, J.Zanchetta, F.Boy, J.Cherville and M.Oberlin.
J. Chim. phys. (France), Vol. 57, No. 10, 892-906 (Oct., 1960). In French.

Studies of Hall effect, magnetoresistance, electrical conductivity, magnetic susceptibility and paramagnetic resonance were made on a series of compounds intermediate between graphite and polycyclic aromatic systems, with results in general agreement with previous data. Correlations were observed between the behaviours of the various parameters, and two critical preparation temperatures are indicated. The number of carriers determined from paramagnetic resonance is in good agreement with that obtained from the low temperature diamagnetism. L.Pincherle

3765 SURFACE MOBILITY OF COPPER IONS ON CUPROUS OXIDE. R.Frerichs and I.Liberman.
Phys. Rev. (USA), Vol. 121, No. 4, 991-6 (Feb. 15, 1961).

The motion of Cu^+ ion vacancies on the surface of cuprous oxide was studied at room temperature with the application of an electric field. The measurement of the mobility of the Cu^+ vacancies was made by means of a time-of-flight procedure. The formation of luminescent centres is the unique property of Cu^+ vacancies that makes them directly observable. The mobility of the Cu^+ vacancies at room temperature is about 10^{-11} cm^2 V^{-1} sec^{-1}. The variation of the mobility with temperatures between 28° to 55° C was observed. From these data the constants of the diffusion equation $D = D_0 \exp(\Delta H/RT)$ are computed: $D_0 = 5 \times 10^{-7}$ cm^2 sec, $\Delta H = 8100$ calories. The low values obtained for these constants shows that the ionic current follows low-resistance paths formed by the crystal grain boundaries or along the surface of the crystal.

3766 PROPERTIES OF ARSENOSELENIDES OF GALLIUM AT HIGH TEMPERATURES. I.Feltin'sh.
Latv. PSR Zinat. Akad. Vestis (USSR), No. 9 (158), 73-8 (1960). In Russian.

Results are presented of a study of the Hall and thermoelectric effects in solid solutions of the system $GaAs–Ga_2Se_3$ in the temperature range 500-1000° K. The number and mobility of current carriers are calculated where they are determined principally by one type of carrier (electrons or holes). It was found that the law of dissipation of current carriers is modified according to the composition of samples. In substances with many structural defects, a sharp decrease of mobility starts at a certain temperature and continues with further rise of temperature.

3767 ELECTRICAL PROPERTIES OF n-TYPE GaSb. A.J.Strauss.
Phys. Rev. (USA), Vol. 121, No. 4, 1087-90 (Feb. 15, 1961).

The electrical conductivity and Hall coefficient of n-type GaSb doped with Se or Te were measured, in most cases at 77° and 300° K, for samples with net donor concentrations between about 6×10^{16} and 2×10^{18} cm^{-3}. In general, the data are consistent with the two-band model which Sagar (Abstr. 2894 of 1960) has proposed for the conduction band of GaSb, but systematic differences are observed between the properties of Se-doped and Te-doped samples. It seems likely that these differences are associated with impurity conduction of the metallic type. For the Te-doped samples, the electron mobility at 77° K apparently varies in an anomalous manner with increasing impurity concentration.

3768 POLAR SCATTERING IN III–V COMPOUNDS. C.Hilsum.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 414-16 (Sept., 1960).

Calculations are made which show that in pure InSb, InAs, InP, GaSb, GaAs and AlSb the carrier mobility is limited by polar optical-mode lattice scattering. The effective mass of holes in InSb appears to be about 0.5 m_0, and in pure GaSb electrons will have a higher mobility than in pure InAs. C.Hilsum

3769 CHEMICAL BOND TYPE AND ELECTRICAL CONDUCTIVITY OF COMPOUNDS WITH FeS_2-TYPE STRUCTURE. L.D.Dudkin and V.I.Vaidanich.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 7, 1526-32 (July, 1960). In Russian.

The electrical resistivity and thermoelectric power were studied for hot-pressed specimens of compounds with pyrites and marcasite structures. A preparational technique for incongruently melting phases is described, $FeSb_2$, $MnTe_2$, $FeTe_2$ and $FeSe_2$ are semiconductors with thermal activation energies of 0.17, 0.48, 0.46 and 0.60-0.95 eV. $CoSe_2$ is metallic. Chemical bonding models for these compounds appear to be in agreement with these findings, provided that with $MnTe_2$ $4s4p^34d^2$ hybridization can be invoked. (See also Abstr. 1459 of 1959 and 1625, 13932 of 1960). [English translation in: Soviet Physics–Solid State (USA)]. C.H.L.Goodman

3770 ELECTRICAL CONDUCTIVITY AND PHOTOCONDUCTIVITY OF LEAD OXIDE LAYERS TREATED WITH SULPHUR, SELENIUM AND TELLURIUM.
P.P.Konorov and A.N.Sokolov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2240-2 (Sept., 1960). In Russian.

Treatment with sulphur and selenium vapours, followed by heating at 250° C for 2-3 min and rapid cooling, produced infrared (extending to 2-2.5 μ) photoconductivity in PbO layers; dark resistivities of treated layers were 10^5-10^6 ohm cm. Similar treatment with tellurium produced no infrared photoconductivity; such photoconductivity appeared after further heating at 350° C for 1-2 hr. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3771 HALL COEFFICIENT AND ELECTRICAL CONDUCTIVITY MEASUREMENTS ON LEAD SELENIDE SINGLE CRYSTALS GROWN FROM THE VAPOUR. R.H.Jones.
Proc. Phys. Soc., (GB), Vol. 76, Pt 5, 783-7 (Nov., 1960).

Measurements were made from 2° to 600° K on four n-type crystals with impurity concentrations ranging from 0.3 to 1.6×10^{17} cm^{-3}, and one p-type crystal with impurity concentration of 1.1×10^{17} cm^{-3}. For three samples the mobility followed a $T^{-2.5}$ law above 50° K. The intrinsic carrier concentration could be determined from the data at temperatures above 300° K. The results obtained were consistent with an energy gap given by $(0.153 + 3.68 \times 10^{-4} T)$ eV. C.Hilsum

3772 DEGENERACY IN Ag_2Te. C.Wood, V.Harrap and W.M.Kane.
Phys. Rev. (USA), Vol. 121, No. 4, 978-82 (Feb. 15, 1961).

The Hall coefficient, resistivity, and Seebeck coefficient of n- and p-type specimens of Ag_2Te were measured over the temperature range from 55 to 300° K. The results indicate that the compound is highly degenerate over the whole temperature range studied. Calculations were made of the effective masses, mobility ratios, and energy gap, and gave order-of-magnitude values.

3773 THE GALVANOMAGNETIC PROPERTIES OF TELLURIUM. II. THE EFFECT OF ANNEALING ON THE TEMPERATURE DEPENDENCE OF THE MOBILITY.
P.V.Parfen'ev, I.I.Farbshtein and S.S.Shalyt.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2923-8 (Nov., 1960). In Russian.

For Pt I, see Abstr. 9202 of 1957. The effect of annealing on the resistivity, Hall mobility and magnetoresistance mobility was measured. Annealing brought about the expected correlation between carrier density and mobility. After the anneal the mobility increased sharply, its temperature dependence assumed its expected form, and the two mobility measurements agreed much better. The reciprocal ohmic mobilities are analysed before and after the anneal and are shown to be additive. The main effect of the anneal is to reduce the temperature-independent term by a factor of about 100. [English translation in Soviet Physics–Solid state (USA)]. M.G.Priestley

3774 ELECTRICAL PROPERTIES OF VARIOUS COMPOSITIONS OF SINTERED ZnO–CuO. R.Trykozko.
Przeglad Elektron. (Poland), Vol. 1, No. 1, 67-70 (1960). In Polish.

The dependence of the conductivity on various factors is illustrated in a number of graphs. Conductance as a function of the composition shows a maximum for 20 wt.% ZnO and a minimum at 90 wt.% ZnO; the maximum is explained by the appearance of a new phase, and the minimum by the compensatory effect of the hole conductance of CuO on the electron conductance of ZnO. Prefiring at 700° C for 20 hours leads to increased conductance because the sintering is more perfect. Increased pressure in moulding increases the conductance of ZnO because of the better adherence of grains, and decreases the conductance of CuO because the oxygen penetration during sintering is reduced; in a composition the effects are additive. Activation energies for various compositions and temperatures of 150° and 500° C are computed. J.M.Silberstein

3775 ELECTRONIC CONDUCTION IN COMPLEXES OF AROMATIC HYDROCARBONS WITH IODINE.
J.Kommàndeur and F.R.Hall.
J. chem. Phys. (USA), Vol. 34, No. 1, 129-33 (Jan., 1961).

Molecular complexes of the aromatic hydrocarbons pyrene and perylene with iodine were found to have an electronic conductivity 10 to 12 orders of magnitude higher than that of the constituent compounds. The specific resistivities measured were 75 and 8 ohm cm, respectively. The materials behaved like semiconductors and plots of log σ versus 1/T gave activation energies of 0.14 eV and 0.019 eV. No Hall effect could be found, but an upper limit for the mobility of $\mu \leq 0.01$ cm^2 V^{-1} sec^{-1} could be set. Single crystals of the perylene–iodine complex were obtained. The preparation and identification of the complexes are discussed and the results of a phase study on the system of pyrene and iodine are reported.

Semiconductor Devices

3776 THE EFFECT OF THE SURFACE RECOMBINATION VELOCITY AND THE ABSORPTION COEFFICIENT ON THE TRANSIENT CHARACTERISTICS OF PHOTODIODES.
A.A.Grinberg and N.B.Strokan.
Fiz. tverdogo Tela, Vol. 2, No. 7, 1536-41 (July, 1960). In Russian.

Shows that the usual values of surface recombination velocities do not greatly affect the transient characteristics of photodiodes. Increase of the surface recombination velocity reduces the response delay and the sensitivity of the diode. On the other hand, a rise of the absorption coefficient k increases strongly the response delay, when $kw \gg 1$ (w is the thickness of the n-region). [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3777 THE TEMPERATURE DEPENDENCE OF THE PRINCIPAL PARAMETERS OF GaAs POINT-CONTACT DIODES. D.N.Nasledov, N.N.Smirnova and B.V.Tsarenkov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2762-9 (Nov., 1960). In Russian.

The preparation of point-contact diodes made of n-type GaAs is described briefly. Current–voltage characteristics of these diodes were obtained between −196° and +300° C. The following parameters were also measured as a function of temperature: differential conductivity at zero applied voltage, pre-exponential multiplier in the expression for forward currents, internal series resistance, cut-off potential, forward currents at various applied voltages, and reverse currents at −1 V. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3778 NUCLEAR METHOD OF MEASUREMENT OF DIFFUSION LENGTH IN P–N JUNCTIONS.
L.Koch, J.Messier and Q.Kerns.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 83-90 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

A p–n germanium junction was irradiated with 4.8, 6 and 8.7 MeV alpha particles and 5, 10 and 11 MeV protons; the incident particles penetrated the crystal perpendicularly to the junction plane. The depletion region was 0.7 μ wide and was located at a distance of 5.3 μ from the crystal surface. The variation of the charge collection efficiency versus incident particle range in the material gives an accurate means of calculating the diffusion length of the minority carriers in the base material.

3779 EXCESS TUNNEL CURRENT IN SILICON ESAKI JUNCTIONS.
A.G.Chynoweth, W.L.Feldmann and R.A.Logan.
Phys. Rev. (USA), Vol. 121, No. 3, 684-94 (Feb. 1, 1961).

At low forward biases, a high current flows in Esaki junctions (Abstr. 2314 of 1958) due to band-to-band tunnelling. At sufficiently high biases the current flows by normal forward injection. Between these two bias ranges, the current is unexpectedly high and has been called the excess current. A comprehensive experimental study was made of this excess current in silicon junctions. It is shown that the properties of the excess current observed so far can be accounted for by a mechanism originally suggested by Yajima and Esaki (Abstr. 12276 of 1958), in which carriers tunnel by way of energy states within the forbidden gap. Based on this model, the following expression for the excess current, I_X, is proposed:

$$I_X \sim D_X \exp\{-(\alpha_X W_1 e^{1/2}/2)[\epsilon - eV_X + 0.6e(V_n + V_p)]\},$$

where D_X is the density of states in the forbidden gap at an energy related to the forward bias, V_X, and the Fermi energies on the n and p sides are V_n and V_p, respectively, e is the electron charge, ϵ is the energy gap, W_1 is the junction width constant, and α_X is a constant containing a reduced effective mass, m_X. This formula describes the observed dependence of I_X (i) on D_X, observed by introducing states associated with electron bombardment, (ii) on ϵ, studied by the temperature variation of the diode characteristics, (iii) on V_X, verified from semilogarithmic plots of the forward characteristics, and (iv) on W_1, tested by using junctions of different widths. From these experiments, $m_X = 0.3m_0$ to within a factor of 2. The origins of the states in the band gap are not known for certain though they are most likely the band edge tails inherent to heavily doped semiconductors. It is probable that the tunnelling-via-local-states model for the excess current in silicon is applicable to excess currents in other materials.

3780 TUNNELING CURRENT IN ESAKI DIODES.
C.W.Bates, Jr.
Phys. Rev. (USA), Vol. 121, No. 4, 1070-1 (Feb. 15, 1961).

The integral giving the net tunnelling current flowing across the junction in an Esaki diode,

$$I = A \int_{E_C}^{E_V} \{f_C(E) - f_V(E)\} Z \rho_C(E) \rho_V(E) dE$$

is evaluated under the normal assumptions that $(\xi_C - E_C)$ and $(E_V - \xi_V)$ are of the order of 2kT. The resulting expression is

$$I = -A'' \frac{(E_V - E_C)^2 (1 - e^{qV/kT})}{(m + n)e^{a/2} + (1 + e^{qV/kT})},$$

where A'' is an arbitrary constant and m, n, and a are functions of the Fermi levels on both sides of the junction, the location of the band edges and the absolute temperature. This expression is plotted as a function of the applied voltage for temperatures of 200°, 300°, and 350° K for donor and acceptor concentrations of 10^{19} cm^{-3} and 1.6×10^{19} cm^{-3}, respectively. The resulting curves compare quite favourably with those of Esaki (Abstr. 2314 of 1958).

3781 VARIATION WITH TEMPERATURE OF THE DISTRIBUTION COEFFICIENT OF INDIUM IN GERMANIUM. M.A.Lee.
Solid-State Electronics (GB), Vol. 1, No. 3, 194-201 (1960).

A relationship is derived for an alloyed-junction transistor giving the solid solubility of the emitter material (indium) in the base crystal (germanium) in terms of the slope of a plot of reciprocal current gain versus emitter current. Measurements were carried out on batches of transistors alloyed at temperatures in the range 350-805° C. The form of the temperature variation of the distribution coefficient deduced from these measurements is in good agreement with that predicted by Hall down to about 550° C. Below this temperature the observed values of the distribution coefficient are higher than would be expected from Hall's relationship. A discussion of the possible causes of this divergence is presented.

3782 THE REGROWN-DIFFUSED TRANSISTOR.
C.H.L.Goodman.
Solid-State Electronics, (GB), Vol. 1, No. 3, 188-93 (1960).

A new process for producing high-frequency n–p–n silicon transistors is described. The novel feature is the formation of a doubly doped region in contact with singly doped material by the direct melting of appropriately doped fragments on to the latter, followed by subsequent solidification. A diffusion cycle then enables the required transistor structure to be developed. The new technique is not limited to silicon and has a number of attractive features among them: simplicity of apparatus, relatively high rate of production and efficient utilization of material.

INTRODUCTION TO SEMICONDUCTOR PARTICLE DETECTORS. See Abstr. 3084

SILICON SURFACE BARRIER DETECTORS WITH CHARGE SENSITIVE AMPLIFIERS. See Abstr. 3085

SILICON γ-RAY SPECTROMETER. See Abstr. 3154

Photoconductivity

3783 INVESTIGATION OF SURFACE RECOMBINATION IN LAYERS OF ORGANIC DYES BY PHOTOCONDUCTIVITY. L.D.Rozenshtein and A.T.Vartanyan.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 3, 567-70 (Sept. 21, 1960). In Russian.

The wavelength dependence of the photoconductivity in both thick and thin layers of the two dyes, pinacyanol and trypaflavine, along with their absorption spectrum, has been examined at room temperature. In addition, the photocurrent flowing per unit absorbed energy, as a function of specimen thickness has been measured at wavelengths corresponding to the edge of the absorption band, the maximum in the band and an intermediate wavelength. The decay of the photocurrent produced by pulsed illumination is used to obtain the value of carrier lifetime. These are 1.1×10^{-4} (and 2×10^{-4} sec) for pinacyanol and trypaflavine, respectively. Along with these results, the values of the diffusion coefficients and surface recombination velocities are found. [English translation in: Soviet Physics—Doklady (USA)].
K.N.R.Taylor

QUASI-FERMI STATISTICS IN PHOTOCONDUCTIVITY. See Abstr. 3852

UNIVERSAL RECOMBINATION VELOCITY FOR PHOTOELECTRIC PROCESSES. See Abstr. 3740

3784 MECHANISM OF PHOTOCONDUCTIVITY IN MICROCRYSTALLINE POWDERS. R.H.Bube.
J. appl. Phys. (USA), Vol. 31, No. 12, 2239-54 (Dec., 1960).

Measurements on a variety of cadmium sulphide powder cells show that there are four different regions encountered as the applied voltage is varied. At low voltages an ohmic region is found in which barrier breakdown does not occur. At intermediate voltages a region is found in which barrier breakdown by a Process I occurs. At still higher voltages a region is found in which barrier breakdown by another Process II occurs in addition to that associated with Process I. At very high voltages another ohmic region is found where all barrier limitations have been removed. It is proposed, on the basis of the data, that Processes I and II are associated either with tunnelling of electrons through interparticle barriers or with a reduction in barrier height assisted by the localized trapping of photo-excited or field-excited holes. A model constructed along these lines is applied to a variety of observations such as current-voltage curves, photocurrent lag after periods of no applied voltage or of opposite-polarity applied voltage, the existence of a semipermanent polarized set, a.c. properties of powders, and the hystersis or storage effect.

3785 SLOW GROWTH OF PHOTOCONDUCTIVITY AS A METHOD FOR DETERMINING PARAMETERS. K.W.Böer and H.Wantosch.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 7, 225-37. In German.

"Electron processes in solids" conference (see Abstr. 2382 of 1961). The slow growth of photoconductivity in CdS crystals, under weak excitation in the tail of the excitation band, was affected by the nature of the contacts, and by internal inhomogeneous layers. In the absence of such layers, trap concentrations and trapping cross-sections can be obtained from the current growth characteristics.
J.Franks

3786 THE PHOTOCONDUCTIVITY OF $CdIn_2S_4$ ACTIVATED WITH Cu OR Au. H.Koelmans and H.G.Grimmeiss.
Physica (Netherlands), Vol. 25, No. 12, 1207-8 (Dec., 1959).

A wide range of resistivities ($1 : 10^8$) is produced, depending on the sulphur pressure. The unactivated samples show a peak photoresponse at 2.1 eV. Variations of the Cd–In ratio do not have a pronounced effect on the sensitivity. Activation increases the sensitivity by about 10^3 the optimum molar concentration being 2×10^{-3}. The dependence of the photocurrent on light intensity is successively linear—superlinear—linear, the superlinear portion seems to depend on a surface layer and can be removed in some samples by grinding.
D.J.Oliver

3787 PHOTOCONDUCTION ACTIVATION ENERGIES IN CIS-TRANS ISOMERS OF β-CAROTENE. B.Rosenberg.
J. chem. Phys. (USA), Vol. 34, No. 1, 63-6 (Jan., 1961).

The activation energies for photoconduction were measured in all trans and 15-15' cis β-carotene powders and in β-carotene glass consisting of a mixture of isomers. The average values of a number of measurements of each are all trans, 0.37 eV; 15-15' cis, 0.20 eV; isomerized glass, 0.19 eV. The values predicted by the triplet state theory of photoconduction are 0.35 (or 0.53), 0.18, and 0.18 eV, respectively. The larger activation energy (two or three vibrational quanta) of the all trans is attributed to the thermal energy necessary to allow an intersystem crossing from the first singlet excited state (about 2.6 eV) to the triplet state (about 3.0 eV). The activation energy of the cis-trans forms of the molecule (1 vibrational quanta) correspond to intersystem crossing from the "cis peak" state (about 3.5 eV) to the triplet state. The excitation spectrum of photoconduction in 15-15' cis β-carotene and isomerized glass, peaks in the "cis peak" region, in agreement with this assignment. These results, that intersystem crossing occurs more readily from the cis peak state than the first singlet excited state, provide an explanation for the shape of the photocurrent excitation spectra in β-carotene and for the lack of phosphorescence in all trans lycopene as reported by Lewis and Kasha.

3788 THE NON-SELECTIVE ACTION OF LIGHT ON THE SURFACE POTENTIAL OF SEMICONDUCTORS AND ESPECIALLY N-TYPE GERMANIUM. A.Surduts.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2329-31 (Nov. 21, 1960). In French.

The surface potential of semiconductors is studied theoretically as a function of the number of photons absorbed on the basis of two models in which different assumptions are made concerning the behaviour of the space charge.
P.T.Landsberg

3789 THE DEPENDENCE OF PHOTOVOLTAGE ON THE WAVELENGTH OF PHOTONS ABSORBED IN GERMANIUM. A.Surduts.
C.R. Acad. Sci. (France), Vol. 251, No. 23, 2665-6 (Dec. 5, 1960). In French.

At a particular wavelength, which depends both on the semiconductor and on the molecules adsorbed at the surface, the normal surface photovoltage is altered. This effect is said to be due to high-energy electrons.
C.Hilsum

3790 INTERBAND PHOTOCONDUCTIVITY IN GERMANIUM T.S.Moss and T.D.H.Hawkins.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 565-6 (Oct., 1960).

Photoconductive effects were observed resulting from transitions between the three distinct valence bands of germanium. The experimental method of recording spectral sensitivity curves at two temperatures is outlined. The effects were as predicted, and an estimate of the time carriers spent on the split-off band was made, giving 4 to 14×10^{-12} sec.
W.Bardsley

3791 IMPURITY PHOTOCONDUCTIVITY IN n-TYPE InSb. E.H.Putley.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 802-5 (Nov., 1960).

In InSb of donor concentration N_D about 3×10^{14} and acceptor concentration such that $N_D - N_A$ is about 4×10^{13} cm^{-3}, the donor centres were found to have an ionization energy which varied from about 7×10^{-4} eV at 8000 G to 3×10^{-4} eV at 4500 G. Such ionization energy levels indicated that impurity photoconductivity ought to be observed with radiation of up to a few millimetres wavelength. The effect was observed at wavelengths of 0.5, 2 and 4 mm. The graphs are given.
W.Bardsley

3792 EFFECT OF RE-CRYSTALLIZATION ON THE TEMPERATURE DEPENDENCE OF PHOTOCURRENT OF SILVER CHLORIDE CRYSTALS. N.Itoh and T.Suita.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1641-2 (Nov., 1959).

Successive re-crystallizations improve photoresponse of crystals through removal of non-metallic impurities.
C.D.Cox

3793 PHOTOCONDUCTIVITY OF SILVER CHLORIDE CRYSTALS UNDER PULSED X-RAY IRRADIATION. A.E.Michel.
Phys. Rev. (USA), Vol. 121, No. 4, 968-77 (Feb. 15, 1961).

The photoconductivity produced by irradiation with 0.2 μsec X-ray pulses was studied in AgCl as a function of temperature (80°-280° K), X-ray intensity and penetration, field strength, and crystal preparation, in order to obtain information about lifetimes and mobilities of electrons and holes. The measurements of electron lifetimes (~ 1 μsec) and mobilities in air-grown crystals are in agreement with those reported in the literature. The photoconductive response can be described by assuming deep electron traps throughout the volume of the crystal and possibly a disturbed surface layer.

No hole motion is observed below 250° K; above that temperature the schubweg per unit field is estimated at 5×10^{-8} cm²/V. The electron lifetime in crystals grown and annealed in He is much smaller than in the air-grown samples. Assuming the same mobility in both samples the lifetime at 80° K is 3×10^{-9} sec. At higher temperatures the pulses show long tails, and between 200° and 280° K the saturation time varies exponentially with 1/T. It is assumed that shallow traps exist (~ 0.08 eV) in a thin surface region which otherwise has a long electron lifetime as compared with the bulk of the crystal. Measurements on crystals doped with 20 p.p.m. Cu^+ indicate that the Cu^+ ions do not act as effective traps. On the other hand, the presence of 1 p.p.m. Ni ions reduces the lifetime at 80° K to less than 3×10^{-11} sec, indicating a capture cross-section of the Ni ion larger than 300 (A)².

PHOTOCONDUCTIVITY OF LEAD OXIDE LAYERS TREATED WITH SULPHUR, SELENIUM AND TELLURIUM. See Abstr. 3770

LUMINESCENT AND PHOTOCONDUCTIVE PROPERTIES OF DOPED GaN. See Abstr. 3861

3794 THE PHOTOMAGNETOELECTRIC EFFECT AND PHOTOCONDUCTIVITY IN SEMICONDUCTORS.
V.Andresciani.
Alta Frequenza (Italy), Vol. 29, No. 2, 154-205 (April, 1960).
In Italian.

A general review which refers to literature up to 1957. The general theory of the effects is outlined for various measuring circuits and the method of determining recombination constants from measurements of both photoconduction and p.m.e. effects is described in detail. The variation of the effects with varying magnetic induction is treated in particular; some original experimental data are presented and discussed. C.A.Hogarth

3795 SOME EXPERIMENTS ON THE FATIGUE AND TEMPERATURE DEPENDENCE OF PHOTOELEMENTS.
E.Helbig and H.Klaus.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 55-7. In German.

The behaviour of two photoelements (Carl Zeiss types A and D) were investigated as a function of temperature, illumination, operating conditions and the time at which measurements were made. C.A.Hogarth

Thermoelectric Properties

3796 MEASUREMENTS OF THERMOELECTRICITY BELOW 1° K. IV.
D.K.C.MacDonald, W.B.Pearson and I.M.Templeton.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 867-70 (Aug., 1960).

To investigate further the finding (Abstr. 18076 of 1960) that the thermoelectric power of Ni, Pd and Fe depended markedly in sign and magnitude on purity, a number of dilute alloys (not more than about 0.5 atomic %) of Cu, Sn and Fe in Pd and Pt was studied. Some results for the most concentrated alloys are shown graphically for the temperature range 0-3° K. Cu or Sn impurities produced monotonic changes in power with temperature (Cu in Pd negative, Sn in Pd positive powers). Fe impurities produced a positive maximum and a subsequent change in sign as temperature was raised. It is concluded that electron scattering by Fe ions must be the basis of an explanation of the anomalous effects of Fe impurity. L.Mackinnon

3797 THERMOELECTRIC PROPERTIES OF THE SILICON–CHROMIUM SYSTEM. E.N.Nikitin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2685-8 (Nov., 1960).
In Russian.

The thermoelectric power and electrical conductivity of Si–Cr alloys were measured as a function of composition. The existence of Cr_3Si, Cr_2Si, Cr_3Si_2, CrSi and $CrSi_2$ was confirmed from the conductivity peaks at these compositions. The thermal conductivity, thermoelectric power and electrical conductivity of pure $CrSi_2$, of $CrSi_2$ with B and Ag impurities and of $CrSi_2$–$MnSi_2$ alloys were measured. The use of these materials in thermoelectric devices is discussed. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3798 THERMOELECTRIC PROPERTIES OF Ag_2Te.
P.F.Taylor and C.Wood.
J. appl. Phys. (USA), Vol. 32, No. 1, 1-3 (Jan., 1961).

The Seebeck coefficient α, electrical conductivity σ, and thermal conductivity K data are given for a number of Ag_2Te specimens measured at room temperature. The maximum value observed for the figure of merit $\alpha^2\sigma/K$ was 1.3×10^{-3} °C^{-1}. The relationship between K and σ was linear, and K_{el} could be expressed approximately by $(\pi^2/3)(k/e)^2\sigma T$.Kph was found to be 0.72×10^{-2} W cm^{-1} °C^{-1}. There was no evidence of an ambipolar diffusion contribution to K. It is suggested that the small energy gap (0.02 eV) previously determined in this compound could account for the absence of a measurable ambipolar diffusion effect, the degeneracy-like behaviour of K_{el}, and the relatively low values of the Seebeck coefficient.

Dielectric Properties

3799 EFFECTIVE IONIC CHARGE IN RELATION TO LATTICE VIBRATIONS. J.R.Hardy.
Phil. Mag. (GB), Vol. 6, 27-35 (Jan., 1961).

A discussion is given of the assumptions involved in recent theories of the dielectric constants of the alkali halide crystals with particular reference to the contributions arising from short-range polarization effects. A theory is developed on a semi-empirical basis which makes it possible to divide this effect unambiguously between the positive and negative ions. This theory is consistent with the experimental data and should provide a means of including this effect in calculations on the lattice dynamics of these crystals.

3800 A STUDY OF DIELECTRIC LOSSES AND PERMITTIVITY OF SOME CERAMICS AT VERY HIGH FREQUENCIES.
V.G.Avetikov, A.S.Zlatkis, M.D.Mashkovets and N.Yu.Rozenberg.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2497-2504 (Oct., 1960).

The permittivity and tan δ of two types of steatite ceramic (SK-1 and TK-21), mullite–corundum ceramics (M-2) and electrical-engineering porcelain (M-23) were measured at 7×10^4-3.75×10^{10} c/s between 20° and 500° C. On increase of frequency from the radio region to v.h.f., the permittivity of all these materials fell and tan δ rose. The rise of permittivity and tan δ on heating was much greater at 1 Mc/s than at 10^{10} c/s. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3801 ON THE PROCESS OF DOMAIN REORIENTATION IN BARIUM TITANATE SINGLE CRYSTALS.
J Stankowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 9, 645-9 (1960).

The effect of one-dimensional pressure and electric fields on crystals with mixed "a" and "c" domains are examined optically. The results appear similar to those obtained by many previous investigators of these properties. L.E.Cross

3802 FERROELECTRIC PROPERTIES OF STRONTIUM–BISMUTH TITANATE. A.N.Gubkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3077-82 (Dec., 1960).
In Russian.

Reports residual polarization, piezoelectric effect, field-dependence of permittivity and tan δ, and polarization hysteresis when strong electric fields are applied to samples of $SrTiO_3$ + + $Bi_2O_3.2TiO_2$ and $SrTiO_3$ + $Bi_2O_3.3TiO_2$. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

3803 THE ASYMMETRY OF PULSED POLARIZATION REVERSAL IN TRIGLYCINE SULFATE FOR DIFFERENT INTERVALS BETWEEN PULSES OF OPPOSITE POLARITY.
L.A.Shuvalov.
Kristallografiya (USSR), Vol. 5, No. 2, 282-7 (March-April, 1960).
In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 262-7 (Sept.-Oct., 1960).

Experimental data are presented on the current and time asymmetry of polarization reversal in plates, to which unequally spaced voltage pulses are applied, as a function of field, temperature and the spacing between pulses of opposite polarity.

3804 PULSED POLARIZATION REVERSAL IN CRYSTALS OF DEUTERATED TRIGLYCINE SULPHATE.
L.A.Shuvalov.
Kristallografiya (USSR), Vol. 5, No. 3, 409-14 (May-June, 1960).
In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 3, 385-9 (Nov.-Dec., 1960).

Experimental data are presented on polarization reversal by periodic, bipolar voltage pulses, and on the dependence of current

and time of polarization on the amplitude of the pulses, on temperature, and on frequency. The pulsed characteristics of ordinary and deuterated triglycine sulphate are compared.

3805 SLOW POLARIZATION PROCESSES IN ROCHELLE SALT EXAMINED BY MEANS OF OBSERVATIONS ON THE DOMAIN STRUCTURE. N.A.Romanyuk and I.S.Zheludev.
Kristallografiya (USSR), Vol. 5, No. 3, 403-8 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 381-4 (Nov.-Dec., 1960).

The domain structure of Rochelle salt subjected to slowly changing electric fields was examined by means of a polarizing microscope; spontaneous decay of a single-domain specimen was examined in the same way. Some results are given on slow cyclic polarization reversal.

3806 DEPENDENCE OF THE MONOCLINIC PIEZOELECTRIC CONSTANTS OF ROCHELLE SALT ON THE DEGREE OF ITS UNIPOLARITY AT DIFFERENT TEMPERATURES.
A.A.Fotchenkov.
Kristallografiya (USSR), Vol. 5, No. 3, 415-19 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 390-5 (Nov.-Dec., 1960).

A study was made of the inverse piezoelectric effect in an X-cut Rochelle salt crystal, in the vicinity of the upper Curie point, for various polarizing fields. The values of the piezoelectric constants d_{11}, d_{12}, and d_{13} and their dependence on the degree of unipolarity in the specimen are given.

3807 SWITCHING PROPERTIES OF TETRAMETHYL-AMMONIUM-TRICHLOROMERCURATE. E.Fatuzzo.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 797-9 (Nov., 1960).

The switching time as a function of applied field is shown to follow a relation of the form $t_S = kE^{-n}$. The exponent n varies approximately linearly with temperature from about 7 at 10°C to about 3 at 200°C. It is suggested that this very unusual behaviour may be explained by assuming a strong field dependence of the domain wall mobility. L.E.Cross

3808 DIELECTRIC PROPERTIES OF FINELY-DISPERSED BARIUM TITANATE. A.L.Khodakov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2126-30 (Sept., 1960). In Russian.

Reports and discusses reasons for the dependence of the dielectric properties of Bakelite—$BaTiO_3$ samples and of pure $BaTiO_3$ ceramics on the particle size (1-10 μ) of the $BaTiO_3$ powder used to prepare them. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

3809 ELECTRICAL IRRADIATION EFFECTS IN SOLID DIELECTRICS. B.Gross and P.V.Murphy.
Nukleonik (Germany), Vol. 2, No. 7, 279-85 (Dec., 1960).

A review of work, mainly by the authors, of electrical breakdown and space charge storage effects induced by electron bombardment in polymers (Plexiglas) and borosilicate glasses. Related topics discussed include differential range distributions of electrons, β-particle transmission currents in solid dielectrics, the thermovoltaic effect and Compton current in γ-irradiated dielectrics, γ-powered detectors and power sources, and current production by neutrons and neutron dosimetry. J.B.Birks

3810 THE EFFECT OF SUPER-VOLTAGES ON THE DIRECTIONAL EFFECT IN THE ELECTRIC BREAKDOWN OF KCl. A.Fernández.
Rev. Mexicana Fis., Vol. 8, No. 4, 243-53 (1959). In Spanish.

Criticizes previous experimental results on breakdown under application of potentials in excess of the critical one, and describes an experiment directed to the elimination of spurious factors. It is found that the direction of breakdown depends on the crystallographic direction. The interpretation of the breakdown process in single crystals is discussed. L.Pincherle

3811 ESTABLISHMENT OF THE PIEZOELECTRIC EFFECT IN ICE. A.Deubner, R.Heise and K.Wenzel.
Naturwissenschaften (Germany), Vol. 47, No. 24, 600-1 (1960). In German.

The largest observed effect corresponded to a piezoelectric modulus of 5×10^{-8} c.g.s. units. This decayed to zero in the course of days. J.E.Caffyn

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

3812 OPTICAL PROPERTIES OF BISMUTH IN BULK IN THE 3-36 μ SPECTRAL REGION.
M.N.Markov and A.S.Khaikin.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 487-92 (Oct., 1960). In Russian.

Reflectivity of bismuth in bulk was measured in the 3-36 μ region and its optical constants were determined. An absorption band was found near 27 μ. The conduction-electron density was estimated at 5×10^{19} cm^{-3}. Properties of bismuth were related to an energy-band model with a forbidden band width of 0.04 eV. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 253-6 (Oct., 1960)]. A.Tybulewicz

3813 THE TRANSMITTANCE AND REFLECTANCE OF GOLD BLACK DEPOSITS IN THE 15- TO 100- MICRON REGION. L.Harris.
J. Opt. Soc. Amer., Vol. 51, No. 1, 80-2 (Jan., 1961).

Differences in the conditions of preparation of the deposits are correlated with differences in their infrared properties. The large change in the absorption in the 15- to 80-μ region is associated with a condenser effect.

3814 REFLECTIVITY OF SILVER CHLORIDE IN THE ULTRAVICLET. P.L.Hartman and R.C.Merrill.
J. Opt. Soc. Amer., Vol. 51, No. 2, 168-70 (Feb., 1961).

The reflectivity of silver chloride was measured at room temperature and at temperatures near those of liquid nitrogen and liquid helium over the wavelength range 2150-3750 A. The reflectivity-transmission cryostat used in making these measurements is described. The results at room temperature show the presence of a reflectivity peak around 2600 A, which is in the vicinity of the first absorption peak. The reflectivity peak sharpens and shifts to shorter wavelengths, attaining a value of nearly 40% at 2300 A when close to liquid helium temperatures.

3815 OPTICAL CONSTANTS OF SILVER.
E.A.Taft and H.R.Philipp.
Phys. Rev. (USA), Vol. 121, No. 4, 1100-3 (Feb. 15, 1961).

The optical constants for electrolytically polished samples were determined from normal-incidence reflectance data in the spectral region 2 to 10 eV. The sharp minimum in the curve for k near 3.8 eV, which is associated with the onset of interband transitions, is deeper than in previous results. A second minimum is observed near 9.2 eV.

3816 INFRARED CHRISTIANSEN FILTER EFFECT WITH BORON NITRIDE. D.Redfield and R.L.Baum.
J. Opt. Soc. Amer., Vol. 51, No 2, 184-5 (Feb., 1961).

Infrared transmission peaks were observed in binary mixtures of boron nitride with several other materials. In addition, pressed pieces of boron nitride alone display a similar peak. The dependence of the wavelengths of the peaks on the refractive index of the second material in mixtures is in accord with the Christiansen filter effect as the explanation of these observations. The similar behaviour in pressed boron nitride is attributed also to the Christiansen filter effect arising from impurities known to be present. For most mixtures one peak occurs between 5 and 6 μ in wavelength and a second peak between 11 and 12 μ. These are associated respectively, with the 7.3 and 12.3 μ absorption bands of the boron nitride. Furthermore, such peaks were produced on the long-wavelength side of these absorption bands by combining boron nitride with a matrix material of appropriately high refractive index. From these observations an approximate dispersion curve for boron nitride is deduced.

3817 THE REFRACTIVE INDEX OF CRYSTALLINE AND FUSED QUARTZ IN THE SPECTRAL REGION NEAR 100 μ. R.Geick.
Z. Phys. (Germany), Vol. 161, No. 1, 116-22 (1960). In German.

The indices (n) are determined from the positions of the maxima and minima in the interference fringes formed by multiple reflection at the plate surfaces. n is plotted for crystal quartz (ordinary ray, λ = 50-200 μ) and for fused quartz (λ = 90-130 μ). Transmission values are plotted for λ = 50-120 μ; crystal quartz shows a dip at 80 μ. G.F.Lothian

3818 USE OF PERTURBATION THEORY IN CALCULATION OF IONIC REFRACTIVITIES OF LANTHANIDES AND ACTINIDES. L.N.Mazalov and S.S.Batsanov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 264-6 (Aug., 1960). In Russian.

Ionic refractivities, R, were deduced from $R = 2.522\ \alpha$, where α is the electronic polarizability calculated using perturbation theory. A formula for α was tested first on alkali and alkaline-earth ions; it was found to give agreement with experiment to within 10%. The same formula was then used to calculate α, and hence R, of lanthanide and actinide ions. Good agreement (to within 2%) was obtained with known experimental values of R for La^{3+}, Ce^{3+} and Nd^{3+}. [English translation in: Optics and Spectrosc.(USA), Vol. 9, No. 2, 137-8 (Aug., 1960)]. A.Tybulewicz

3819 VOIGT EFFECT IN SEMICONDUCTORS. S.Teitler and E.D.Palik.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 546-8 (Dec. 15, 1960).

The theory of the double refraction of an e.m. wave passing through an isotropic semiconductor under the influence of a static transverse magnetic field H is developed and verified experimentally on n-type InAs, with carrier concentration of 10^{17} cm^{-3}, for infrared radiation of $\lambda = 14\text{-}19\ \mu$. Fields as high as 70 kG were used. A study of this effect provides the effective mass and its variation with H. Preliminary results were obtained also for InSb. L.Pincherle

3820 OPTICAL BEHAVIOUR OF VISCOELASTIC MATERIALS WITH HIGH TEMPERATURES AND LARGE TIMES OF LOADING. J.Montilla, D.Tinaut and L.Villena.
An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 55, No. 7-8, 198-206 (July-Aug., 1959). In Spanish.

Additional results are given for a number of transparent plastics which were studied previously (see Abstr. 9023 of 1957). Curves showing the variation of birefringence and strain with temperature for various loads and varying loading times are presented. The temperature range covered is 25 to 110°C, and loading times up to 48 hours were used. It was found that at some critical temperature, lying between 70 and 90°C, the plastics become quasi-elastic and this critical temperature is not influenced by the way in which the temperature is reached. The suitability of each material for frozen stress work is also studied and designated by a figure of merit. A table is drawn up which gives the moduli of elasticity, the photo-elastic constants and the figures of merit of the samples tested at both room and critical temperatures. H.G.Jerrard

3821 ON THE PROBLEM OF THE PHOTOELASTIC RESPONSE OF A VISCOELASTIC MATERIAL IN THE DYNAMIC REGION. A.Lagarde.
C.R. Acad. Sci. (France), Vol. 251, No. 5, 633-5 (Aug. 1, 1960). In French.

The problem is discussed theoretically and the deductions compared with results for experiments made on two types of Araldite and CR 39. It is found that the photoelastic response is in phase with the deformation. H.G.Jerrard

3822 EXPERIMENTS ON FERROMAGNETIC LAYERS WITH OPTICAL AND ELECTRON IRRADIATION. H.Boersch.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 78-85. In German.

Using apparatus for observing the Faraday effects for both normal and tangential magnetization of films, the Faraday constants and the maximum rotation of the plane of polarization for given external magnetic field were determined for thin iron films. A method for the construction of Weiss' circuit in the electron microscope is described and the domain structure and rotation effects are reported. C.A.Hogarth

3823 THEORY OF LINE-SHAPES OF INTERBAND MAGNETO-OPTICAL ABSORPTION IN SEMICONDUCTORS. T.Ohta, M.Nagae and T.Miyakawa.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 229-50 (Feb., 1960).

The theory is developed with use of the two complementary approximations, one of which is an approach from the strong magnetic field and the other from the weak field. The interaction between carriers and phonons is taken into account by the method of generating function. The results for the scattering probability and the self-energy are shown to be in good agreement with the observed values. The calculated line-shape which corresponds to the minimum photon energy can fairly explain the observed behaviour.

3824 CHANGES IN THE OPTICAL PARAMETERS OF CRYSTALS CAUSED BY ELECTRIC FIELDS (THE LINEAR ELECTROOPTICAL EFFECT).
O.G.Vlokh and I.S.Zheludev.
Kristallografiya (USSR), Vol. 5, No. 3, 390-402 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 368-80 (Nov.-Dec., 1960).

The equations for the optical indicatrices are derived by considering the symmetry changes caused by electric fields acting along the principal directions in the crystal; these equations contain the field, as well as the refractive indices. The orientation of the new indicatrix with respect to the usual one is given as a function of those same variables.

3825 ELECTRO-OPTICAL EFFECT OF ZINCBLENDE. S.Namba.
J. Opt. Soc. Amer., Vol. 51, No. 1, 76-9 (Jan., 1961).

The electro-optical coefficient of zincblende is measured by using the Senarmont compensator method for various wavelengths between 404 and 644 mμ and the application of the crystal as a light modulator of wide optical aperture is discussed. The electro-optical coefficient is found to be 5.9×10^{-8} cm/statvolt at room temperature for wavelength of 546 mμ. The voltage for obtaining half-wave retardation is about 10 kV.

3826 NOTE ON THE TREATMENT OF IMPURITY SCATTERING IN OPTICAL ABSORPTION IN SEMICONDUCTORS. B.Donovan.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 574-7 (Oct., 1960).

The infrared absorption cross-section for impurity scattering in n-type germanium is evaluated for the frequency range in which experimental results are available. The calculation is based on a corrected form of Meyer's calculation (Abstr. 4458 of 1959). These results are compared with the treatment of impurity scattering used by Rosenberg and Lax (Abstr. 4582 of 1959), which were based on the Born approximation. It is shown that Meyer's calculation, which avoids use of the Born approximation, is more accurate, particularly at low temperatures. This is despite the fact that Meyer neglects the screening of the impurity potential. A.J.Fox

3827 EXCITON ABSORPTION OF LIGHT IN Cu_2O CRYSTALS. II. THE CASE OF ABSENCE OF CONSTANT EXTERNAL FIELDS. S.A.Moskalenko.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 369-75 (Sept., 1960). In Russian.

For Pt I, see Abstr. 20983 of 1960. The treatment in Pt I is extended by a discussion of the hole bands of p-type, of the exciton spectrum related to excitation of oxygen ions, and of fundamental frequencies of the Cu_2O lattice vibrations. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 192-5 (Sept., 1960)]. A.Tybulewicz

3828 VIBRATIONAL SPECTRA OF SILICATES. III. EQUATIONS OF VIBRATIONS OF PLANE SILICON–OXYGEN RINGS IN SILICATES. A.M.Prima.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 452-9 (Oct., 1960). In Russian.

For Pt II, see Abstr. 1499 of 1960. Reports a theoretical study of vibrations of silicon–oxygen rings of D_{nh} symmetry. Using complex coordinates to allow for symmetry, general matrices are obtained for reduced kinematic and dynamic coefficients and selection rules applicable to various types of structure and symmetry. Symmetry types whose frequencies are independent of the number of silicon atoms in a ring are determined. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 236-9 (Oct., 1960)]. A.Tybulewicz

3829 SPLITTING OF THE FUNDAMENTAL ABSORPTION EDGE OF Cu_2O CAUSED BY THE REMOVAL OF DEGENERACY OF BANDS BY UNIAXIAL DEFORMATION OF THE CRYSTALS. E.F.Gross and A.A.Kaplyanskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 7, 1676-7 (July, 1960). In Russian.

The positions of the long-wavelength absorption edges and the first exciton line were measured as a function of applied stress. When pressure was applied along [100] or along [111] each edge was split into two but when it was applied along [110] they were split into three components. The splitting was proportional to the applied stress and was of the order of 1 A mm^2/kg. From the degeneracies

and the polarization of the edges it was deduced that one of the bands has a threefold degenerate extremum at k = 0. [English translation in Soviet Physics–Solid State (USA)]. M.G.Priestley

3830 POLARIZATION IN THE ABSORPTION SPECTRUM OF CUBIC CUPROUS OXIDE.
I.S.Gorban' and V.B.Timofeev.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2077-8 (Sept., 1960). In Russian.

Confirms an earlier report (Abstr. 11762 of 1960) that a fundamental absorption line at 16294.5 cm^{-1} is polarized both in monocrystals and in polycrystals of Cu_2O. [English translation in: Soviet Physics — Solid State (USA)]. A.Tybulewicz

3831 MAGNETIC AND SPECTRAL PROPERTIES OF THE SPIN-FREE $3d^6$ SYSTEMS IRON(II) AND COBALT(III) IN COBALT(III) HEXAFLUORIDE ION: PROBABLE OBSERVATION OF DYNAMIC JAHN–TELLER EFFECTS.
F.A.Cotton and M.D.Meyers.
J. Amer. Chem. Soc., Vol. 82, No. 19, 5023-6 (Oct. 5, 1960).

The electronic (d–d) absorption spectra of the $3d^6$ systems in several salts containing either $[Fe(H_2O)_6]^{2+}$ or $(CoF_6)^{3-}$ were studied. In all cases, this is a distorted or double absorption band contrary to what would be expected assuming Russell–Saunders coupling and ligand fields of regular octahedral symmetry. It is concluded that spin–orbit coupling effects are an order of magnitude too small to account for the observed splittings and that in only a few cases might the splittings be attributable to permanent, ground-state distortion of the octahedra. It is proposed that in most cases these splittings are due to a dynamic Jahn–Teller effect in the electronic excited states. The order of magnitude of the splittings agrees well with a prior theoretical estimate made by Liehr and Ballhausen (Abstr. 4385 of 1958). The magnetic behaviour of Co(III) in K_3CoF_6 is shown to agree well with theoretical predictions contrary to the implication of earlier data.

3832 EFFECT OF PRESSURE ON THE SPECTRA OF RARE EARTH IONS IN CRYSTALS.
K.B.Keating and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 34, No. 1, 143-51 (Jan., 1961).

The observed effects up to 180 000 atm include: (1) an increase of intensity due to increased mixing of 5d and 4f orbitals in the excited state due to an increase of the mixing potential with decreased interionic distance. (2) Small shifts accompanied by increases in half-width. Except for the shifts of $^3P_0$, $^3P_1$, and $^3P_2$ levels of Pr^{+3}, these can be accounted for by an increase in the splitting of the individual levels due to intensification of the crystal field. (3) Changes in shape of several of the bands, possibly due to changes in occupation of the various states which make up the bands.

3833 PRESSURE EFFECTS IN NICKEL DIMETHYLGLYOXIME AND RELATED CHELATES.
J.C.Zahner and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 33, No. 6, 1625-8 (Dec., 1960).

The effect of pressure on the absorption peak characteristic of the solid phase of certain metal chelates was measured for $Ni(DMG)_2$, $Pd(DMG)_2$, $Pt(DMG)_2$, Ni nioxime, Pd nioxime, Ni benzoxime, and Ni heptoxime. The peak shifts strongly red with pressure. At high pressure the shift levels off for nickel, tends to reverse for palladium and reverses strongly for platinum. There is considerable pressure broadening. These and other related observations are consistent with the assignment of the transition as from the A_{1g} (or A_{1g} and E_g) ground state to the A_{2u} (P_z) excited state.

3834 EFFECT OF PRESSURE ON THE SPECTRA OF CRYSTALLINE UF_4 AND UF_3. K B.Keating and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 34, No. 1, 140-2 (Jan., 1961).

Measurements showed that the UF_3, which has a structure analogous to PrF_3 and NdF_3, behaved much like those compounds, showing a 15% to 40% increase in intensity for different peaks in 50 000 atm. In UF_4 certain of the peaks increased in intensity while others decreased. The U^{4+} ion is almost at a centre of symmetry in this crystal. It is indicated that the intensity behaviour is reasonable if a significant fraction of the intensity is obtained due to lattice vibrations. Both red and blue shifts are observed on different peaks.

3835 LOW-TEMPERATURE ABSORPTION SPECTRA OF SOME SYNTHETIC CRYSTALS COLORED BY NICKEL.
S.V.Grum-Grzhimailo, N.A.Brilliantov, R.K.Sviridova and O.N.Sukhanova.
Kristallografiya (USSR), Vol. 5, No. 2, 288-94 (March-April, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 268-73 (Sept.-Oct., 1960).

The absorption spectra of $NiSO_4.6H_2O$ (uniaxial tetragonal) and $NiSO_4.7H_2O$ (biaxial orthorhombic) are reported for temperatures down to 1.7°K. Spectra showing narrow polarized absorption bands are described. The spectrum varies with the valence of the nickel ions introduced into the crystal.

3836 THE ABSORPTION EDGE IN OXIDES OF ALKALINE-EARTH METALS. V.P.Rombakh.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 258-9 (Aug., 1960). In Russian.

Shows that Shamovskii's relationship (1938) between the crystal lattice energy and the fundamental absorption edge of alkali-halide crystals is applicable in the case of oxides of alkaline-earth metals, such as MgO, CaO, SrO and BaO. [English translation: Optics and Spectrosc. (USA), Vol. 9, No. 2, 134 (Aug., 1960)]. A.Tybulewicz

3837 A NEW BAND IN THE ABSORPTION SPECTRUM OF POLYCRYSTALLINE CADMIUM SULPHIDE LAYERS.
T.Ya.Sëra and V.V.Serdyuk.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 407-9 (Sept., 1960). In Russian.

Heating in air for 5 min at 300°C produced a band at 485 mμ; the same band appeared on heating in vacuo, i.e. it was not due to interaction with atmospheric oxygen. Additional experiments showed that heating caused local cracks (visible under a microscope) and metal atoms collected in these cracks, producing centres responsible for the new band. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 210-11 (Sept., 1960)]. A.Tybulewicz

3838 PROPERTIES OF THE Cu_2O STRUCTURAL LINE WITH THE LONGEST WAVELENGTH.
I.S.Gorban' and V.G.Timofeev.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 482-6 (Oct., 1960). In Russian.

A Fabry–Perot interferometer coupled to a spectrograph was used to study the ~16 000 cm^{-1} line at temperatures down to 20°K. It was confirmed that the line is part of the fundamental absorption of cuprous oxide. The fall of the line frequency with increase of temperature was related to interaction of excitons with the lattice. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 250-2 (Oct., 1960)]. A.Tybulewicz

3839 α AND β BANDS IN SODIUM CHLORIDE.
J.D.Rigden.
Phys. Rev. (USA), Vol. 121, No. 2, 357-8 (Jan. 15, 1961).

The peak energies of the α and β bands were measured at 77°K with a vacuum ultraviolet monochromator. The β bands was well defined, and occurred at 7.40 eV with a half-width of 0.4 eV. The oscillator strength of the β band was calculated to be 0.55. No resolved α band could be produced, but subtraction of absorption curves indicated that it occurred near 7.20 eV.

3840 ABSORPTION SPECTRA OF F_2^-, Cl_2^-, Br_2^-, AND I_2^- IN ALKALI HALIDES.
C.J.Delbecq, W.Hayes and P.H.Yuster.
Phys. Rev. (USA), Vol. 121, No. 4, 1043-50 (Feb. 15, 1961).

After X-ray irradiation at liquid nitrogen temperature, holes are trapped by forming F_2^- molecule ions in LiF; Br_2^- molecule ions in KBr containing one of the impurities Ag^+, Tl^+, Pb^{2+}, or NO_2^-; and I_2^- molecule ions in KI containing one of the impurities listed above. An investigation of the optical and paramagnetic resonance spectra of crystals containing F_2^-, Br_2^-, and I_2^- centres leads to an identification of the optical transitions of these centres. The polarizations and relative intensities of the optical absorptions in the X_2^- molecule ion series are discussed with reference to the energy-level scheme to be expected for such a species.

3841 ABSORPTION SPECTRUM OF TELLURIUM MONOSULPHIDE IN THE ULTRAVIOLET REGION.
H.Mohan and K.Majumdar.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 147-52 (Jan., 1961).

Two new absorption band systems were observed in the quartz ultraviolet region (λλ 2190-2450) by vaporizing tellurium in vacuum

together with the sulphide of a group IIb element. The bands, which are degraded to the violet, were classified and attributed to a new molecule TeS.

3842 INVESTIGATION OF THE LONG-WAVELENGTH FUNDAMENTAL ABSORPTION IN POLYCRYSTALLINE LAYERS OF CdS AND ZnSe AT LOW TEMPERATURES.
E.F.Gross, B.S.Razbirin and V.I.Safarov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2945-9 (Nov., 1960). In Russian.

The absorption spectra of CdS and ZnSe layers, produced at two temperature ranges, were recorded at 77.3°K. The layers at lower temperatures showed a broad abosrption edge with little structure, while those produced at higher temperatures exhibited three absorption peaks near the edge. Two of these were sharp (10 A width), and the other, was broad (30 A). Heat treatment of the former layers caused the optical properties to change and become comparable with those of the high-temperature layers. [English translation in: Soviet Physics—Solid State (USA)].
K.N.R.Taylor

3843 INFRARED SPECTRUM AND FORCE FIELD OF CRYSTALLINE HYDROGEN PEROXIDE.
R.L.Miller and D.F.Hornig.
J. chem. Phys. (USA), Vol. 34, No. 1, 265-72 (Jan., 1961).

The infrared spectrum of crystalline and vitreous hydrogen peroxide was studied from 300 cm^{-1} to 4000 cm^{-1}. A normal coordinate analysis of the tetragonal crystal with four molecules/unit cell is given. The hydrogen bonds are only slightly weaker than in H_2O but the O—H linewidths are only 80 cm^{-1}. From the coupled motion of the torsion and the high frequency libration, the torsional frequency in the gas is estimated to be about 230 cm^{-1}.

3844 ABSORPTANCE OF GOLD IN THE FAR INFRARED
L.Harris and P Fowler.
J. Opt. Soc. Amer., Vol. 51, No. 2, 164-7 (Feb., 1961).

The reflectances of seven gold mirrors were measured accurately for wavelengths from 8.5 to 84 μ. The absorptances, calculated from the reflectances, were used to determine the nature of the reflection of the electrons in gold at the gold-air interface.

3845 INFRARED LATTICE BANDS OF QUARTZ.
W.G.Spitzer and D.A.Kleinman.
Phys. Rev. (USA), Vol. 121, No. 5, 1324-35 (March 1, 1961).

The infrared lattice bands of α-quartz were investigated at 297°K from 5 to 37 μ in reflection and transmission with polarized light. Previously published measurements of the optical constants do not agree in this spectral range. It is shown that dispersion theory can fit the data within experimental error throughout the range, and accurate values of the dispersion parameters and the optical constants are obtained. This is the first accurate dispersion analysis of a complex spectrum. A study was made of the accuracy of the Kramers--Kronig method of analysis on this spectrum. The strength, width, and frequency of 14 optically active lattice vibrations are given, 4 of which have not previously been established. From a consideration of published Raman data, 10 of the resonances are assigned according to symmetry type as fundamental vibrations.

3846 THE INFRA-RED ABSORPTION SPECTRA OF POTASSIUM MANGANICYANIDE AND VANADIUM CORUNDUM. G.D.Jones and W.A.Runciman.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 996-8 (Dec., 1960).

Polarization spectra in the region 7000 A - 12 000 A were photographed for crystals immersed in liquid nitrogen. Four potassium manganicyanide lines, all partially polarized, were observed at 10410, 10470, 10570 and 10850 A. The occurrence of lines in this region was deduced from Tanabe—Sugano diagrams. The vanadium corundum line at 9660 cm^{-1} was largely π polarized, in agreement with results of Pryce and Runciman (Abstr. 20991 of 1960).
K.A.Thomas

3847 THE ABSORPTION OF QUARTZ IN THE NEAR INFRARED. H.G.Hüfele.
Z. Phys.(Germany), Vol. 160, No. 4, 420-30 (1960). In German.

In the region 3000-4000 cm^{-1}, crystal quartz has 3 bands due to the SiO_2 lattice and 3 arising from OH groups. These latter (a) are enhanced by electrolysis at 950°C in H_2, (b) disappear after electrolysis in N_2, and (c) after irradiation with neutrons they disappear and are replaced with bands at a higher wave-number (3600 cm^{-1}). These latter bands correspond to vibrations of more or less free OH groups in interstitial positions; the change (c) is reversed by heating to 950°C.
G.F.Lothian

SPLITTINGS OF d^n-TERMS IN STRONG COMPLEX FIELDS OF TRIGONAL AND RHOMBIC SYMMETRIES. See Abstr. 3620

INFRARED ABSORPTION OF THE A-CENTRE IN IRRADIATED SILICON. See Abstr. 3657

3848 DISTORTION OF THE X-RAY ABSORPTION EDGES IN METALS AND ALLOYS DUE TO LATTICE VACANCIES. A.N.Nigam.
Z. Phys. (Germany), Vol. 161, No. 5, 496-9 (1961). In German.

A mechanism involving lattice vacancies is proposed to account for the distortion in the shape of absorption edges. It is shown that an atom near a lattice vacancy will be under the influence of an electrical field resulting from the asymmetric surroundings. The magnitude of this field is found to be large enough to produce a Stark-splitting in the exciton orbit of the absorbing atom. The distortion appearing as a kink on the slope of the absorption curve is shown to be a consequence of this splitting.

Luminescence

3849 NINTH CONFERENCE ON LUMINESCENCE (CRYSTAL PHOSPHORS). N.A.Tolstoi.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 277-9 (Aug., 1960). In Russian.

Gives brief descriptions of the leading papers presented at the Conference held in Kiev on 20-25 June, 1960. About a third of the 120 papers presented dealt with ZnS-type phosphors and another third dealt with alkali halides. [English translation in: Optics and Spectrosc. (USA)].
A.Tybulewicz

3850 SOME PROBLEMS OF CRYSTAL LUMINESCENCE.
V.L.Broude, A.F.Prikhot'ko and E.I.Rashba.
Uspekhi fiz Nauk (USSR), Vol. 67, No. 1, 99-117 (Jan., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2(67), No. 1, 38-49 (Jan.-Feb., 1959).

A review of the luminescent behaviour of single crystals, which concentrates on the properties of molecular crystals and on the role of exciton states in the energy transfer chain between absorption and emission. Luminescence involving direct and indirect transitions from the exciton states of molecular, ionic and valence crystals is contrasted. For ideal crystals, at low temperatures, the exciton luminescence is expected to be strongly inhibited in general. A survey of experimental work on luminescence, mostly of Soviet origin, leads to the conclusion that, in real crystals, the emission generally takes place at lattice defects or impurities which have energy levels close to the fundamental absorption edge of the crystal lattice. Optical absorption, for energies close to the forbidden gap, is shown to produce a mixture of different types of excited state. It is concluded that excitons act predominantly as energy transfer states between the host lattice and impurities or lattice defects, some of which may be deactivated by radiative processes.
P.J.Dean

3851 THE PROBLEMS OF THE DEFECTS IN THE PROCESS OF EXCITON LUMINESCENCE OF MOLECULAR CRYSTALS. V.M.Agranovich.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 1, 141-9 (May, 1960). In Russian.

A theoretical discussion in terms of polaritons, which are excitation states existing as mixtures of excitons and transverse photons, when the retardation interaction is taken into account. Circular dichroism in optically active crystals at low temperatures is predicted. The transformation of exciton energy into light at a defect can occur with or without localization of the exciton energy at the defect. The former should lead to non-exponential decay, the latter to exponential decay. The role of triplet states, which may act as defects, is considered, and it is pointed out that the luminescence intensity associated with "triplet" defects produced by the irradiation, should be proportional to the square of the intensity of the incident light, while the luminescence intensity associated with defects existing prior to irradiation should be proportional to the first power of the incident intensity. [English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 427-33 (Nov.-Dec., 1960)].
J.B.Birks

3852 THE APPLICATION OF QUASI-FERMI STATISTICS TO PROBLEMS OF LUMINESCENCE AND PHOTOCONDUCTIVITY. I.Broser.
Abhandl. Deutschen Akad. Wiss. Berlin,Kl. Math. Phys. Tech. (Germany), 1960, No. 7, 45-56. In German.

"Electron processes in solids" conference (see Abstr. 2382 of 1961). The use of the familiar quasi-Fermi levels is advocated for problems of luminescence and photoconduction. A number of relevant experimental results is presented. P.T.Landsberg

3853 LUMINESCENCE OF A FREE EXCITON IN A MOLECULAR CRYSTAL.
Yu.M.Popov and A.S.Selivanenko.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 260-1 (Aug., 1960). In Russian.

Gives a calculation of the probability of annihilation of a free exciton with simultaneous emission of a photon and a phonon, using the second approximation of the perturbation theory. For acoustic phonons the probability of such exciton annihilation rises with lowering of temperature. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 135 (Aug., 1960)]. A.Tybulewicz

3854 EMISSION SPECTRA OF TRIVALENT THULIUM.
L.G.Van Uitert and R.R.Soden.
J. chem. Phys. (USA), Vol. 34, No. 1, 276-9 (Jan., 1961).

Trivalent thulium can be caused to fluoresce selectively from different levels by choice of the wavelength of exciting radiation. This has made it possible to correct the assignments of emission transitions occurring in the visible range. As a consequence, the detailed data of Gobrecht were found to be in much closer agreement to the theoretical predictions than formerly realized.

3855 LUMINESCENCE OF ETHANOLAMINE COMPOUNDS OF PLATINUM. A.M.Tkachuk and N.A.Tolstoi.
Optika i Spektrosk.(USSR), Vol. 9, No. 2, 261-4 (Aug., 1960). In Russian.

Reports the luminescence spectra at −196°C and the temperature dependence (−183 to 150°C) of the luminescence relaxation times of several ethanolamine compounds of platinum: $PtEtm_2I_2$, $PtEtm_2Br_2$, $PtEtm_2Cl_2$ and diethanolamine compounds: $PtDEtm_2I_2$, $PtDEtm_2Br_2$, $PtDEtm_2Cl_2$. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 136-7 (Aug., 1960)]. A.Tybulewicz

3856 LUMINESCENCE OF THALLIUM CHLORIDE.
V.A.Sokolov and N.A.Tolstoi.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 421-3 (Sept., 1960). In Russian.

Thallium chloride monocrystals were excited with 365 mμ light in an atmosphere of pure helium. Blue luminescence was observed at 460 mμ in pure crystals; it was due to structural defects whose density depended on the thermal history of crystals. Plastic deformation produced a band at 620 mμ. A band with a maximum at 740 mμ appeared after heating at 250-350°C in pure dry helium (1-10 mm Hg), due to loss of chlorine. Illumination with 365 mμ light above −150°C reduced luminescence intensity, in contrast to heating in darkness which intensified luminescence. Recovery of the ability to luminesce of samples de-excited by ultraviolet illumination probably occurred due to decomposition of quenching centres by heating in darkness. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 219-20(Sept., 1960)]. A.Tybulewicz

3857 AN ELECTRON SPIN RESONANCE STUDY OF THE ACTIVATOR-VALENCE CHANGE ON EXCITATION OF THE SrS:Eu:Sm PHOSPHOR. V.G.Dubinin and Z.A.Trapeznikova.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 360-4 (Sept., 1960). In Russian.

A fall in electron-spin resonance absorption of Eu^{2+} was observed on photoexcitation of SrS:Eu:Sm in the absorption band of Eu^{2+}. It was concluded that photoexcitation ionized the activator: $Eu^{2+} \rightarrow Eu^{3+}$. [English translation in: Optika and Spectrosc. (USA) Vol. 9, No. 3, 187-9 (Sept., 1960)]. A.Tybulewicz

3858 AN ELECTRON SPIN RESONANCE STUDY OF SrS:Eu PHOSPHORS. V.G.Dubinin and Z.A.Trapeznikova.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 472-7 (Oct., 1960). In Russian.

Comparison of stored (on excitation) and liberated (on de-excitation) light sums showed that in the phosphors prepared without a flux only about half the number of recombinations produced photons, while in the phosphors prepared with a flux practically all recombinations produced luminescence. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 4, 245-8 (Oct., 1960)]. A.Tybulewicz

3859 THEORY OF THE PULSATION OF FLUORESCENT LIGHT FROM RUBY. R.W.Hellwarth.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 9-12 (Jan. 1, 1961).

A treatment is outlined accounting for the observation that, when pump power exceeds a threshold value, part of the fluorescence is as recurrent pulses (Abstr. 21007 of 1960). The theory is in terms of the pump power and the ordinary properties of the crystal and end-plates. A quantitative expression is derived for the time between pulses, which is predicted to fall as the pump power increases, but relatively slowly at powers well beyond the threshold value. The fraction of total output light emitted during the pulses is expressed approximately; it is of the order of 25% at pump powers slightly above threshold, and greater at larger pump powers. The state populations during and between pulses are quantitatively discussed, and the extension of the treatment to the observed spectral and spatial narrowing of the emitted light during pulses is indicated. The work is compared with similar studies of microwave ruby masers and gas masers. J.Sheridan

3860 LINE FLUORESCENCE SPECTRA OF ORGANIC COMPOUNDS AND THEIR APPLICATIONS.
É.V.Shpol'skii.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 2, 215-42 (June, 1960). In Russian.

Results obtained on finely crystalline solid solutions of a series of polynuclear aromatic hydrocarbons containing condensed benzene rings in normal paraffins at and below 77°K are discussed. The fine structure and reproducibility of the fluorescence spectrum under these conditions enable it to be used for the detection of intermolecular and intramolecular interactions and for identification of individual compounds under difficult conditions, such as heavy hydrocarbons in petroleum. [English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 372-89 (Nov.-Dec., 1960)]. G.I.W.Llewelyn

3861 LUMINESCENT AND PHOTOCONDUCTIVE PROPERTIES OF DOPED GaN.
H.G.Grimmeiss, R.Groth and J.Maak.
Z. Naturforsch. (Germany), Vol. 15a, No. 9, 799-806 (Sept., 1960). In German.

Methods of making GaN are reviewed and a new one described, which is to heat LiGa in NH_3 at 350°C. The latter produces GaN containing Li, but other additives producing specific emissions under 3650 A radiation include Zn, Cd, Hg and S. Details of different emission bands, especially at 90°K, are given and their dependence on heat treatment of the material discussed. Infrared quenching, temperature quenching, and photoconductivity were also studied. An energy level diagram is given, including shallow traps revealed by the glow curve experiment. Transitions between these traps and the valency band are seen as "satellite" emission near the violet end of the visible spectrum. S.T.Henderson

3862 FIELD ENHANCEMENT IN ZnS.CdS:Mn PHOSPHORS.
G.Wendel.
Z.Naturforsch. (Germany), Vol. 15a, No. 11, 1010-11 (Nov., 1960). In German.

These phosphors, not containing Au, when made into cells like those used for electroluminescence, show an increase of up to 10 times in their X-ray luminescence by simultaneous exposure to an a.c. field. At constant frequency this enhancement factor rises with the applied voltage to a flat maximum near 300 V. At constant voltage the factor falls steadily as frequency increases from 0.1 to 10 kc/s. Enhancement also occurs with ultraviolet, cathode-rays or α-particles instead of X-rays. S.T.Henderson

3863 FIELD ENHANCEMENT IN ZnS.CdS:Mn PHOSPHORS UNDER X-RAY EXCITATION.
H.Winkler, H.Röppischer and G.Wendel.
Z. Phys. (Germany), Vol. 161, No. 3, 330-8 (1961). In German.

A more detailed account of the work described in the preceding abstract. The enhancement factor was measured for blue, yellow and red wavelengths of the emission, being greatest for the yellow

(near the emission peak), and here also the fall with frequency increase was most marked. "Memory" experiments showed that exposure to the field alone produced a temporary enhancement of luminescence in a later exposure to X-rays. The amount of enhancement was greater for a longer pre-exposure to the field, but decreased as the interval between the two exposures was lengthened. Other effects of varied field strength, frequency, and X-ray intensity are described. S.T.Henderson

DIRECT OBSERVATION OF EXCITON MOTION IN CdS.
See Abstr. 3636

3864 A NOTE ON THE DECAY KINETICS OF LUMINESCENCE OF AgCl SINGLE CRYSTALS. K.Vacek.
Abhandl. Deutschen. Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 7, 208-13. In German.

"Electron processes in solids" conference (see Abstr. 2382 of 1961). Measurements of the decay of luminescence on normal and stressed crystals shows two modes of decay: initially a hyperbolic and later an exponential time dependence. The model proposed consists of two similar centres with energy levels, i.e. cation vacancies in the crystal body and at dislocations. One decay process is associated with these centres by transitions of captured electrons from conduction band or polaron levels, the other with exciton annihilation through phonon interaction. F.Ansbacher

3865 KINETICS OF SHORT-LIVED PHOTOLUMINESCENCE OF SOME ACTIVATED ALKALI-HALIDE CRYSTALS.
I.K.Vitol and I.K.Plyavin'.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 365-8 (Sept., 1960). In Russian.

Deals with the effect of two lower excited levels of Ga^+, In^+ and Tl^+ activator ions on the kinetics of short-lived photoluminescence of KI:Ga, KI:In and KI:Tl crystals. The temperature dependences of the decay time constants were obtained. The results agree well with theory and some luminescence-centre parameters are deduced. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 189-91 (Sept., 1960)]. A.Tybulewicz

3866 INVESTIGATION OF THE DURATION OF PHOSPHORESCENCE IN SOLUTIONS OF ORGANIC COMPOUNDS AT -196^0 C.
E.N.Viktorova, I.A.Zhmyreva, V.P.Kolobkov and A.A.Saganenko.
Optika i Spektrosk. (USA), Vol. 9, No. 3, 349-52 (Sept., 1960). In Russian.

An analysis of the duration of phosphorescence at -196^0 C showed that in many organic compounds a change in the ratio of the quantum yields of phosphorescence and fluorescence is a fairly accurate measure of a change in the probability of transitions of excited molecules into metastable states when the surrounding medium is altered. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 181-3 (Sept., 1960)]. A.Tybulewicz

3867 THE KINETICS OF PHOTOCONDUCTIVE AND PHOSPHORESCENT PROCESSES. M.Schön.
"Semiconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 282-356. In German.

These processes can be explained as the results of recombination of lattice defect sites of positive and negative charge carriers, created by excitation, and a theoretical model is proposed, capable of representing all cases of radiating and non-radiating recombinations. Calculations are made of capture effects, decay phenomena, quenching and stimulation. A.Landman

3868 PREPARATION OF ZnS-TYPE PHOSPHOR LAYERS WITH MICROCRYSTALLINE STRUCTURE BY SYNTHESIS ON GLASS PLATES. J.Wojciechowski.
Przeglad Elektron. (Poland), Vol. 1, No. 1, 106-8 (1960). In Polish.

Describes the preparation of ~1-100 μ thick ZnS layers by reaction of H_2S at 1-2 torr with Zn and $ZnCl_2$ vapours (containing $MnCl_2$, $CuCl_2$,etc., as activators) at 500-550^{0}C. Preliminary photoluminescent and cathodoluminescent measurements are reported. A.Tybulewicz

3869 THE EXCITATION AND INFLUENCING OF LUMINESCENCE BY ELECTRIC FIELDS. D.Hahn.
Ergeb. exakt. Naturwiss. (Germany), Vol. 31, 1-83 (1959). In German.

Review article.

3870 A NEW ELECTROLUMINESCENCE EFFECT IN BLACK CARBORUNDUM. A.G.Gol'dman.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1108-10 (Dec. 11, 1960). In Russian.

The voltage dependence of light intensity for both types of electroluminescence emission from black SiC was investigated. The measurements include observation of the intensity as a function of frequency for pulsed excitation with various pulse magnitudes. In addition, a third type of emission is reported whose intensity is independent of pulse frequency and arises in the region of electron injection. It differs from the other emission associated with injection, which occurs while the voltage is applied, in that it becomes visible after the voltage is reduced to zero. The colour of this emission is different from that of the other two kinds of electroluminescence in carborundum. [English translation in: Soviet Physics—Doklady (USA)]. K.N.R.Taylor

3871 A NOTE ON ELECTROLUMINESCENCE DUE TO CARRIER ACCUMULATION.
H.K.Henisch and B.R.Marathe.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 782-3 (Nov., 1960).

Low's suggested mechanism of minority carrier accumulation under a field (Abstr. 5406 of 1955) may be involved in electroluminescence. This could occur in an n-type region adjacent to an n^+ region to which current is flowing. In contrast to the carrier injection case, recombination luminescence would occur near the cathode and to a depth decreasing with increase of the field. S.T.Henderson

3872 THE CHEMILUMINESCENCE OF CHLOROPHYLL IN PHOTOCHEMICAL REACTIONS.
F.F.Litvin, Yu.A.Vladimirov and A.A.Krasnovskiĭ.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 1, 149-56 (May, 1960). In Russian.

A red chemiluminescence during the reverse oxidation of the intermediate photoreduced forms of chlorophyll, and a chemiluminescence upon irradiation of chlorophyll solutions in the presence of air, were observed and studied. A study was made of the afterglow and thermoluminescence of films of chloroplasts, extracts and pure pigments, and of the relation of these effects to the temperature and the presence of oxygen during the irradiation. [English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 434-9 (Nov.-Dec., 1960)]. J.B.Birks

3873 STIMULATED INFRARED EMISSION FROM TRIVALENT URANIUM. P.P.Sorokin and M.J.Stevenson.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 557-9 (Dec. 15, 1960).

Crystals of calcium fluoride were grown in which U^{3+} ions replace certain Ca^{2+} ions. After absorption of visible light, the crystals showed strong fluorescence, with four peaks in the range 2.0 - 2.6μ. The two peaks at longest wavelengths are due to emission, from metastable states 4647 and 4531 cm^{-1} above the ground state, to a level about 515 cm^{-1} above the ground state (see Galkin and Feofilov, Abstr. 133 of 1958), Because the population of the last level at low temperatures is only some 10^{-10} times that of the ground state, maser oscillations at 2.49 μ due to the longest wavelength emission can be observed with much lower optical pumping power than when emission to a ground state is involved. Stimulated emission was obtained with pumping powers some 500 times less than those required for stimulated emission to the ground level in ruby crystals (Abstr. 20988, 21007 of 1960). Brief details of apparatus and observations are given. At liquid helium temperatures, the stimulated emission exceeded the spontaneous emission by a factor of several thousand. Relaxation oscillations observed in the maser output are briefly discussed. The favourable energy level structure of U^{3+} may soon provide a strong c.w. infrared source. J.Sheridan

MAGNETIC PROPERTIES OF SOLIDS

3874 THE THEORY OF THE s–d MODEL. N.A.Potapkov and S.V.Tyablikov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2733-42 (Nov., 1960). In Russian.

The s–d model of the interaction of the electrons responsible for magnetic properties with the conduction electrons is studied. The excitation spectrum and the magnetic properties are calculated to third order in the coupling constant. The method of temperature Green's functions is used. [English translation in: Soviet Physics–Solid State (USA)]. D.J.Thouless

3875 FERROMAGNETIC-ANTIFERROMAGNETIC INTERACTION IN Fe–FeS. J.H.Greiner, I.M.Croll and M.Sulich.
J. appl. Phys. (USA), Vol. 31, No. 12, 2316-17 (Dec., 1960).

Exchange anisotropy effects, unidirectional properties, and a non-vanishing rotational hysteresis at high fields have been observed for compacts of fine sulphide-coated iron particles. A sin θ variation of the torque and a non-vanishing value of the rotational hysteresis for applied magnetic fields greater than $2K/I_s$ were found for samples cooled in a magnetic field from the Néel temperature of FeS. Samples cooled in a demagnetized state displayed no measurable change of torque with angle. S.A.Ahern

3876 DIAMAGNETISM OF A DENSE ELECTRON GAS. H.Kanazawa and N.Matsudaira.
Progr. theor. Phys. (Japan), Vol. 22, No. 3, 463-5 (Sept., 1959).

Wentzel (Abstr. 5102 of 1958) concluded that the Landau expression for the diamagnetic susceptibility is unaffected by the Coulomb interaction. It is pointed out that certain contributions to the susceptibility were neglected but a discussion of these is deferred. D.M.Edwards

3877 DIAMAGNETISM OF ELECTRONS IN A WEAK PERIODIC POTENTIAL. R.M.May.
Progr. theor. Phys. (Japan), Vol. 23, No. 3, 400-7 (March, 1960).

A method developed by Blatt, Matsubara and May (Abstr. 16947 of 1960) for evaluating the magnetic response of a system in a non gauge-invariant approximation is illustrated by a simple example: that of electrons moving in a weak periodic lattice. The result is in quantitative agreement with more detailed gauge-invariant calculations by other authors. The calculation is also of interest in that is provides an example where use of the "London gauge", div A = 0, leads to unphysical results.

3878 EFFECT OF LATTICE-ELECTRON INTERACTION ON THE LANDAU DIAMAGNETISM. S.Tani.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1157-62 (June, 1960).

A theory of the Landau diamagnetism is presented, in which the interaction of electrons with lattice vibrations connected with virtual exchange of phonons is taken into account. Calculation is made up to the second-order perturbation; a suitable canonical transformation can eliminate the first-order term of lattice-electron interaction. The result gives only a small correction to the diamagnetism.

3879 CALCULATION OF THE DIAMAGNETIC ANISOTROPY OF SOME GRAPHITIC SYSTEMS. J.Hoarau
J. Chim. phys. (France), Vol. 57 No. 10, 855-8 (Oct., 1960).
In French.

London's theory of the diamagnetism of aromatic molecules is used to calculate the diamagnetic anisotropy of planar graphitic ribbonlike structures infinitely long and 2, 3, or 4 benzene type rings wide. It is shown that the resulting secular equation can be treated by molecular orbital methods. P.M.Parker

3880 ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF MONOCRYSTALLINE GRAPHITE. J.W.McClure.
J. Chim. phys. (France), Vol. 57, No. 10, 859-65 (Oct., 1960).

The electronic structure of graphite at and near the top of the occupied energy band is described. The problem of the electronic band structure determination from experimental results on cyclotron resonance, de Haas van Alphen effect and diamagnetic susceptibility is discussed. It is shown that London's theory of the diamagnetism of aromatic molecules can be applied to graphite and leads to large diamagnetism. A short comment concerning diamagnetic effects in small particles of graphite is given. P.M.Parker

3881 PARAMAGNETISM: A KEY TO THE KNOWLEDGE OF CHEMICAL BONDING. J.A.McMillan.
Amer. J. Phys., Vol. 29, No. 3, 207-10 (March, 1961).

The phenomenological classification of substances on the basis of their magnetic behaviour is given. Together with the explanation of paramagnetism, cases are discussed in which this property changes with coordination. Simple qualitative experiments are described.

3882 MAGNETIC MOMENT OF TRANSITION METAL ATOMS IN DILUTE SOLUTION AND THEIR EFFECT ON SUPERCONDUCTING TRANSITION TEMPERATURE. B.T.Matthias, M.Peter, H.J.Williams, A.M.Clogston, E.Corenzwit and R.C.Sherwood.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 542-4 (Dec. 15, 1960).

Solutions of Fe in Ti, V or Nb (columns 4 and 5 of the periodic table) show no temperature-dependent susceptibility χ. It is now found that solutions in alloys of Nb with Mo (column 6) show an abrupt growth of χ from zero at Mo concentrations above 40%. Mo is non-superconducting, but the alloy $Mo_{0.8}Re_{0.2}$ shows an abrupt depression of T_C when Fe is added, whereas in Ti, Zr, V and Nb, T_C is raised, or lowered only slightly, by Fe. It is concluded that localized spins exist on Fe atoms dissolved in elements of column 6, but not 4 or 5. R.G.Chambers

N-InSb; CONNECTION BETWEEN OSCILLATORY MAGNETORESISTANCE AND THE DE HAAS–VAN ALPHEN EFFECT. See Abstr. 2412

3883 COLLECTIVE EXCITATIONS OF ELECTRONS IN DEGENERATE BANDS. I. SPIN WAVES IN STONER'S MODEL OF FERROMAGNETISM. T.Izuyama.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 969-83 (June, 1960).

Spin waves in the collective electron model of ferromagnetism are derived in a completely similar manner to that adopted in deriving exciton waves in insulators. The internal motion of an electron–hole pair forming the spin wave with a long wavelength is shown to be localized in the ordinary space. The frequency of the spin wave with long wavelength coincides with the result obtained by Yosida and Kasuya (1956) in the case where all electron spins are pointed toward the same direction in the ground state. It is concluded generally that spin waves break down unless there is a sufficiently large difference between the number of the electrons with up spin and the number of those with down spin.

3884 SCATTERING OF SPIN WAVES AND PHONONS ON IMPURITIES IN FERRODIELECTRICS. V.G.Bar'yakhtar and G.I.Urushadze.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 355-61 (Aug., 1960). In Russian.

The effect of impurities on the thermal conductivity of a ferrodielectric at low temperatures is examined. The thermal conductivity coefficient of a ferrodielectric containing impurities is computed. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 2, 251-5 (Feb., 1961)].

MAGNETIC PROPERTIES OF THE SPIN-FREE $3d^6$ SYSTEMS IRON(II) AND COBALT(III) IN COBALT(III) HEXAFLUORIDE ION. See Abstr. 3831

A MECHANISM FOR ULTRASONIC ABSORPTION IN PARAMAGNETIC METALS IN A MAGNETIC FIELD. See Abstr. 3599

3885 SPONTANEOUS MAGNETIZATION, A GENERALIZED SQUARE LATTICE. I.Syozi and S.Naya.
Progr. theor. Phys. (Japan), Vol. 23, No. 2, 374-6 (Feb., 1960).

3886 A STUDY OF THE MAGNETIC PROPERTIES OF SOME Cu–Ni–Fe ALLOYS. D.Bally and A.Glodeanu.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 4, 445-55 (1957). In Roumanian.

A study was made of the manner in which the magnetic properties of four alloys in this series depend upon the duration of heat treatment at 550° C. The structure is single-phased above 650° C and

two-phased below this temperature. An increase in the remanance, the coercive force and the Curie point is observed in every case as a function of the duration of the heat treatment. There is an interval of relative concentrations of Fe/Cu, corresponding to a given concentration of Ni, where the coercive force attains a maximum value. The Curie point determinations indicate that concentration variations reach appreciable values only before the heat treatment.
F.E.Hoare

3887 MAGNETIC PROPERTIES OF VERY PURE IRON. T.Nagashima.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 148-54. In German.

The preparation of the iron specimens is described in detail. The influence of grain size and direct demagnetization (either by thermal or compensating field) is studied in relation to the magnetic properties. The methods of obtaining square-loop hysteresis curves are discussed.
C.A.Hogarth

3888 CRYSTALLINE FIELD SPLITTING IN FERROUS FLUOSILICATE. T.Ohtsuka.
J. Phys. Soc. Japan, Vol. 14, No. 9, 1245 (Sept., 1959).

The magnetic susceptibility parallel and perpendicular to the trigonal axis of a single crystal of ferrous fluosilicate is reported in the temperature range 1.4°K to 20°K, together with the susceptibility for the powdered material. The results are briefly discussed.
R.Parker

3889 MAGNETIC PROPERTIES OF Fe_3P. M.C.Cadeville and A.J.P.Meyer.
C.R. Acad. Sci. (France), Vol. 251, No. 16, 1621-2 (Oct. 17, 1960). In French.

Fe_3P is a normal ferromagnetic with a Curie point of 443°C, and a saturation moment of 1.840 μ_B per iron atom. At 16°C the magnetization vector is held in the base plane of the tetragonal lattice by an anisotropy energy of $(5.3 \times 10^6 \sin^2\theta + 2.4 \times 10^6 \sin^4\theta)$. The maximum value of coercive force observed at 18°C is 107 Oe.
S.A.Ahern

3890 THEORY OF THE FERROMAGNETISM OF NICKEL. J.Seiden.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2311-13 (Nov. 21, 1960). In French.

The Van Vleck model is elaborated to show that the low temperature variation of the magnetization follows the spin wave law, with a correction factor also as $T^{3/2}$ but with a coefficient which is negligibly small if the period of exchange between a d^{10} and a d^9 ion is less than about 10^{-14} sec.
E.P.Wohlfarth

3891 VARIATION OF THE CURIE TEMPERATURES IN THE ALLOYS Ni–Cu–Sn. I.Maxim, D.Ausländer and V.Stan.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 2, 143-5 (1957). In Roumanian.

The Curie temperatures of two solid solution series, with Cu:Sn = 4 and $\frac{1}{2}$, vary approximately linearly with the mean valency of the additives.
E.P.Wohlfarth

3892 THE LAW OF ELECTRONIC CONCENTRATION IN THE FERROMAGNETISM OF NICKEL ALLOYS. I.Maxim.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 3, 331-5 (1958). In Roumanian.

The Curie temperature of the ternary alloys Ni–Cu–M (M = Al, Au, Sn) and Ni–Au–Al in solid solution follows the classical law

$$\theta = \theta_{Ni}(1 - nc/60),$$

where c is the atomic concentration and n the mean valency.
E.P.Wohlfarth

3893 THE DIRECTIONAL DEPENDENCE OF THE MAGNETIC PROPERTIES OF SILICON-IRON ALLOYS WITH CUBIC STRUCTURE. H.E.Möbius.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 175-80. In German.

The secondary recrystallization texture of these alloys may take several forms. The most interesting, from the point of view of magnetic anisotropy, is the cubic modification. The properties of alloys crystallized in this form are investigated and compared with published results on other structures.
C.A.Hogarth

3894 UNIAXIAL MAGNETIC ANISOTROPY OF EVAPORATED THIN COBALT FILMS. Z.Málek and W.Schüppel.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 109-14. In German.

Systematic measurements are made on layers deposited on heated or non-heated substrates and with different magnetic fields used during the deposition. The mean value of the anisotropy constant is about 2×10^4 erg cm^{-3}.
C.A.Hogarth

3895 DIRECT MEASUREMENT OF THE UNIAXIAL MAGNETIC ANISOTROPY OF EVAPORATED THIN FILMS OF IRON, NICKEL, PERMALLOY AND COBALT. Z.Málek and W.Schüppel.
Ann. Phys. (Germany), Vol. 6, No. 5-6, 252-61 (1960). In German.

Torque measurements on films evaporated in the presence of a magnetic field onto heated and unheated substrates, placed both perpendicular and at an angle to the evaporation direction, show uniaxial anisotropy which is made up of at least two parts. One part is time-dependent and associated with the applied magnetic field, the other time-independent and identified with the geometric anisotropy.
A.J.Manuel

3896 SOME MAGNETIC PROPERTIES OF PRECIPITATION HARDENING Fe–Mo AND Cu–Ni–Fe ALLOYS. V.I.Ivanovskii.
Fiz. Metallov i Metallovedenie (USSR), Vol. 4, No. 2, 245-8 (1957). In Russian.

The alloys were 82 : 18 Fe–Mo and 52 : 36 : 12 Cu–Ni–Fe. Ferromagnetic precipitates, isolated from one another by non- or weakly-magnetic regions, appeared during precipitation from supersaturated solid solutions. This type of structure can give high coercivity. The time and temperature dependences of the magnetization and coercivity were investigated.

3897 MAGNETOCALORIC EFFECT IN THE LOW-TEMPERATURE RANGE OF THE TRANSFORMATION OF MAGNETITE. V.P.Krasovskii and I.G.Fakidov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8) 235-41 (Aug., 1960). In Russian.

The temperature dependence of the reversible magnetocaloric effect was studied on single crystals between 80° and 290°K. Two minima were discovered which are explained by a change in the anisotropic properties of the crystal. The effect of the conditions of cooling of the magnetite on the magnitude of the magnetocaloric effect was studied. An irreversible change of the temperature in a relatively narrow temperature range (95–115°K) was also detected. [English translation in: Soviet Physics - JETP (USA), Vol. 12, No. 1, 170-4 (Feb., 1961)].

3898 MAGNETIC INTERACTION DOMAINS. D.J.Craik and E.D.Isaac.
Proc. Phys. Soc. (GB). Vol. 76, Pt 1, 160-2 (July, 1960).

The growth of a spike-like domain structure, similar to that observed for a normal uniaxial material, was observed during the demagnetization of an ESD iron compact. This structure is proposed to result from the magnetostatic interactions between the particles.
E.P.Wohlfarth

3899 DOMAIN CONFIGURATIONS ABOUT NONMAGNETIC PARTICLES IN IRON. W.D.Nix and R.A.Huggins.
Phys. Rev. (USA), Vol. 121, No. 4, 1038-42 (Feb. 15, 1961).

The closure domain configuration about a nonmagnetic particle in iron is considered in terms of magnetostatic, interfacial wall, and magnetostrictive energies. Equations for the total energy of the domain configuration and the value of the geometrical parameter θ are derived. The effects of particle size and shape are considered.

3900 DOMAIN WALLS IN THIN FERROMAGNETIC Ni–Fe FILMS. S.Middelhoek.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 119-23. In German.

Two types of domain wall are observed for extremely thin and extremely thick layers, as predicted by Néel. The mode of transition from one type to another is explained. This is confirmed by observing Bitter figures at scratches in Ni–Fe films showing negative magnetostriction.
C.A.Hogarth

3901 MEASUREMENT OF OPTIMUM DOMAIN WIDTH IN SILICON–IRON. R.Carey.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 567-9 (Oct., 1960).

The domain width D was observed by means of the powder pattern technique as a function of L, the crystal grain length in the (100) direction, in a specimen of 3% silicon–iron. Grains were selected with 0.04 cm < L < 0.3 cm and a roughly linear relation was found between L and D. The domain width in a given crystal grain depends to some extent upon the shape of the grain and upon the surrounding grains. R.Parker

3902 TEMPERATURE HYSTERESIS OF THE DOMAIN IN SILICON IRON CRYSTALS.
Ya.S.Shur and I.E.Startseva.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 566-73 (Sept., 1960). In Russian.

The domain structure of silicon iron crystals before and after heating from room temperature to 550°C was studied by the powder-pattern technique. It was found that, as a result of cyclic variation of the temperature, the form of the domain structure changed irreversibly: the dimensions, shape and number of closure domains changed and the boundaries between the main regions became displaced. The observed regularities are explained by the domain theory of the structure of ferromagnets. [English translation in: Soviet Physics–JETP (USA)].

3903 MAGNETIC PROPERTIES OF MAGNETICO-ANISOTROPIC SPECIMENS COMPOSED OF FERROMAGNETIC POWDERS. IV. VARIATION WITH TEMPERATURE OF THE MAGNETIC PROPERTIES OF MnBi ALLOY POWDER SPECIMENS.
Ya.S.Shur, E.V.Shtol'ts and G.S.Kandaurova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 3, 420-5 (1958). In Russian.

For Pt III, see Abstr. 3002 of 1960. The anisotropy of the coercivity was studied between −196° and +20°C. The magnetization curves, return curves and minor hysteresis loops were studied at −196°C. It is shown that, on lowering the temperature of specimens made from fine powders, from +20° to −196°C, the magnetic structure of the particles is modified, because of the reduction in the anisotropy constant. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 3, 43-7 (1958)].

3904 REVERSIBLE AND IRREVERSIBLE MAGNETIZATION VARIATIONS IN THIN MAGNETIC FILMS. W.Dietrich.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 115-18. In German.

For the demagnetization of evaporated thin films of the permalloy type, three different mechanisms must be distinguished. displacement and incoherent and coherent rotation of the walls. All three processes can be observed during the magnetization and demagnetization by short pulses. The experimental method for measuring very rapid (10^{-9} sec) coherent rotational processes is described with examples of measurements. C.A.Hogarth

DOMAIN STRUCTURE OF THIN IRON FILMS. See Abstr. 3822

3905 EFFECT OF ELASTIC STRESSES ON THE MAGNETIC STRUCTURE OF SILICON IRON CRYSTALS.
Ya.S.Shur and V.A.Zaikova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 3, 545-54 (1958). In Russian.

The changes in magnetic structure were studied — using powder figures — in relation to the magnitude of the stresses, the initial magnetic structure and the orientation of the stresses along the crystallographic axes. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 3, 158-66 (1958)].

3906 THE EFFECT OF THE INTERNAL STRESS ON THE LONGITUDINAL MAGNETOSTRICTION IN WEAK MAGNETIC FIELD. VI. S.Matsumae.
Kumamoto J. Sci. A (Japan), Vol. 4, No. 3, 167-75 (Feb., 1960).

For Pt III, see ibid., Vol. 4, No. 1, 76 (1959). Results for Ni–Mn (0.12%), Fe–Ni (69.93%), Fe–Ni (50.24%), Fe–Co (68.85%), Fe–Co (19.59%) and pure Fe are presented. Fields of up to about 2 Oe and compressive and tensile stresses up to 3 kg/mm² were used and measurements were made both before and after a.c. demagnetization. A.J.Manuel

3907 THE MAGNETOSTRICTION OF LITHIUM–CHROMIUM FERRITE IN THE NEIGHBOURHOOD OF ITS COMPENSATION POINT. E.W.Lee and R.R.Birss.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 411-12 (Sept., 1960).

It was shown previously (Abstr. 1951 of 1952; 8569 of 1953) that certain antiferromagnetic substances exhibit rapid changes in Young's modulus with temperature in the region immediately below the Néel temperature. It is not, however, possible to investigate this directly in antiferromagnetics; and so measurements were made on a ferrite ($Li_{0.5}Fe_{0.8}Cr_{1.7}O_4$) in the region of its compensation temperature, because at the compensation point the ferrite may be considered as an antiferromagnetic. Measurements were made by observing the strain in a polycrystalline disk as it was rotated in a field of 5000 Oe over the temperature range from −200° to +100°C. The results show that there is no anomalous behaviour in the region of the compensation temperature. It is therefore concluded that the magnetostriction is determined by the magnetic moment of the individual sub-lattices and not by the net moment. S.A.Ahern

3908 THE TEMPERATURE DEPENDENCE OF MAGNETOSTRICTION. E.A.Turov and A.I.Mitsek.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 6, 1847-51 (June, 1960). In Russian.

The temperature dependence of linear (anisotropic) and volume (isotropic) magnetostriction is investigated in the low-temperature range using a phenomenological spin-wave theory. [English translation in: Soviet Physics–JETP (USA), Vol. 11, No. 6, 1327-31 (Dec., 1960)].

3909 FERROMAGNETIC RELAXATION CAUSED BY INTERACTION WITH THERMALLY EXCITED MAGNONS.
E.Schlömann.
Phys. Rev. (USA), Vol. 121, No. 5, 1312-19 (March 1, 1961).

The contribution of three-magnon processes to the relaxation rate of spin waves is investigated. Relaxation occurs through the confluence of two magnons (with the generation of a third magnon), and through the splitting of a magnon into two magnons. The relaxation rate due to the confluence process is approximately proportional to the wave number, whereas that due to the splitting process is approximately independent of the wave number. The latter contribution vanishes at frequencies higher than $\frac{2}{3}(\gamma 4\pi M)$ (γ = gyromagnetic ratio, M = saturation magnetization), and increases with decreasing frequency. The implications of the theory with respect to the observation of spin-wave instability in a r.f. magnetic field parallel to the d.c. field are discussed.

3910 METALLIC MAGNETIC MATERIALS AT HIGH FREQUENCIES. R.Boll.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 63-73. In German.

Discrepancies exist between the critical frequency determined experimentally and that calculated from the classical eddy-current theory. In thin sheets in particular these discrepancies are partly due to electron spin relaxation. The classical formula for the critical frequency must therefore be extended and two possible methods for doing this are given. R.Parker

3911 NEW VARIETIES OF MAGNETIC MATERIALS. R.M.Bozorth.
Research (GB), Vol. 13, No. 12, 485-91 (Dec., 1960).

The various kinds of magnetism are discussed in terms of (1) the interatomic forces on which they are based and (2) the bulk properties exhibited by the materials. Special consideration is given to recent work on magnetic garnets into which various elements have been incorporated and to some rare-earth compounds which are both superconducting and ferromagnetic.

3912 THE MECHANISMS OF THE FORMATION OF SEPARATE DISPERSION REGIONS IN THE PERMEABILITY SPECTRA OF FERROMAGNETIC SEMICONDUCTORS.
L.A.Fomenko.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 534-7 (Oct., 1960). In Russian.

Gives a brief review of Western and Soviet (including the author's own) work on permeability spectra of ferrites with one, two or three dispersion regions. A.Tybulewicz

3913 ORIGIN OF THE MAGNETIC ANISOTROPY ENERGY OF COBALT FERRITE. M.Tachiki.
Progr. theor. Phys. (Japan), Vol. 23, No. 6, 1055-72 (June, 1960).

The magentic anisotropy is considered to arise from the cobaltous ions in the crystalline field of a low symmetry. The crystalline field due to the averaged-out charged distribution of Co^{2+} and Fe^{3+} ions in the octahedral sites gives the lowest-lying twofold degenerate orbital level of the Co^{2+} ion and to this level are associated four spin levels, corresponding to $S = \frac{3}{2}$, as each spin is subject to exchange field. Each of these orbitally doubly degenerate levels is further split into two by the low symmetry field arising from the difference of charges of Co^{2+} and Fe^{3+} ions and spin-orbit coupling. The magnitude of this energy splitting depends on the direction of the exchange field, thus on the direction of the magnetization, and from this origin the anisotropy energy arises. The relation between the magnitude of the anisotropy energy and the strength of the low symmetry field is discussed. Two kinds of configuration, A and B, of the Co^{2+} and Fe^{3+} ions neighbouring each Co^{2+} ion are considered as having low energy values. By properly choosing the relative numbers of Co^{2+} ions in these A and B configurations and the strengths of the respective low symmetry fields, the calculated temperature dependence of the cubic anisotropy constant K_1 can be fitted with that measured by Shenker. The values of the parameters thus determined seem to be reasonable, as they can be compared with those calculated on the assumption of the point charge model. The magnetic moment consisting of the spin and orbital moments is calculated to be $3.4 \sim 3.5\ \mu_B$ per Co^{2+} ion. Finally, the dependence of the anisotropy constant of the mixed Fe–Co ferrite on the concentration of the cobaltous ions is discussed.

3914 ELECTRON-MICROSCOPIC INVESTIGATIONS OF THE CRYSTALLIZATION PROCESS IN FERRITES AND THE INFLUENCE OF THE STRUCTURE ON THEIR MAGNETIC PROPERTIES. E.Lăbuşča, I.Teodorescu and I.Mirion.
Rev. de Physique (Roumania), Vol. 5, No. 2, 239-45 (1960). In German.

The article shows 16 microphotographs of magnification ×9000 and ×18000 of the surface of a ferrite during the process of formation by sintering. Corresponding magnetic measurements of the ratio B(rem) to B(max), i.e. the degree of rectangularity of the hysteresis loop, are quoted. The ratio generally increases with sintering temperature up to about 0.9. No details of composition or heat treatment are given. R.Parker

3915 THEORY OF THE TEMPERATURE DEPENDENCE OF THE INTENSITY OF MAGNETIZATION AND PARAMAGNETIC SUSCEPTIBILITY OF FERRIMAGNETIC MATERIALS. A.A.Gusev.
Kristallografiya (USSR), Vol. 5, No. 3, 420-5 (May-June, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 3, 396-401 (Nov.-Dec., 1960).

For a magnetically isotropic single crystal of a two-sublattice ferrimagnetic material with different numbers of magnetic ions in the sublattices and arbitrary values of spin and magnetic moments of the magnetic ions in each sublattice, equations are derived (of the type of molecular field equations) for the intensity of magnetization, based on previously developed theory (Abstr. 13824 of 1960). A formula for magnetic susceptibility in the paramagnetic region, and the temperature dependence of the intensity of magnetization in the region of the Curie point are established.

3916 NEW POSSIBLE PHENOMENON IN ANTIFERROMAGNETICS. H.Cofta.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 8, 547-51 (1960).

Obtains the dispersion laws in the case of superstructural anisotropy of spin wave dispersion (Abstr. 12669 of 1960). Experimental evidence verifying this anisotropy might be obtained by means of neutron scattering or spin-wave resonance. It should then be possible to estimate the ratio of nearest to next nearest neighbour exchange integrals. E.P.Wohlfarth

3917 THE ROLE OF INDIRECT EXCHANGE INTERACTION IN THE THEORY OF MAGNETISM OF THE TRANSITION METALS AND RARE EARTHS. II. ANTIFERROMAGNETISM. B.V.Karpenko, A.A.Berdyshev, R.B.Zaks and L.M.Noskova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 481-7 (April, 1960). In Russian.

Second approximation of the perturbation theory in the s–d exchange model of the transition metals leads to the appearance of indirect interaction between electrons of the d-shell, counteracting the direct antiferromagnetic bond in antiferromagnetic materials. The interaction between the conduction electrons and the spin-waves of the ferro- and antiferromagnetic material changes the linear term in the expression for the specific heat of the metal. M.H.Sloboda

3918 THE ESTIMATION OF ANTIFERROMAGNETIC EXCHANGE INTERACTIONS.
A.Danielian and K.W.H.Stevens.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 116-23 (Jan., 1961).

The estimation of the interaction energies between the magnetic ions in antiferromagnetic crystals is investigated and it is shown that they may be obtained from measurements of the magnetic susceptibility in the paramagnetic phase. High-temperature power-series expansions of the zero-field susceptibility–well known in connection with ferromagnetic systems — are analytically continued by means of the transformation $1/w+1/z-\theta$ so that the series no longer diverge at the ferromagnetic Curie point and the domain of convergence is extended towards lower temperatures. See also following abstract.

3919 THE ANTIFERROMAGNETISM OF $CoCO_3$
R.A.Alikhanov
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1481-3 (Nov., 1960). In Russian.

Neutron diffraction patterns of an artificially prepared crystalline specimen of $CoCO_3$, at 4.2°K and using small reflection angles, showed (111) and (100) peaks which have an antiferromagnetic origin. They were absent at 20.4°K. There were some differences compared with the neutron diffraction patterns of $MnCO_3$. The direction of the antiferromagnetic moments made $46^\circ \pm 4^\circ$ with the [111] axis. Other evidence from the (211) reflection indicated also the presence of weak ferromagnetism. The suggestion that the substance is in state II of the three states predicted by a thermodynamic theory due to Dzyaloshinskii (1957), is partly supported, partly opposed. Another discrepancy may be due to the uncertainty in the value of the saturation moment of the Co^{2+} ion. See also Abstr. 3224 of 1958. N.Davy

3920 EXCHANGE INTERACTIONS IN THE POLYMORPHIC FORMS OF MnS. A.Danielian and K.W.H.Stevens.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 124-8 (Jan., 1961).

Analytically continued high-temperature power-series expansions developed in the preceding paper are applied to the susceptibilities of the polymorphic forms of MnS, all three of which are known to be antiferromagnetic. An isotropic Heisenberg interaction is assumed between nearest neighbours only. Estimates of the exchange interaction are obtained using experimental data from the region above the Néel temperature but below the Curie–Weiss region. It is found that $|J|/k$ is $(12.4\pm0.5)^\circ$K for β-MnS (zinc blende) and $(10.7\pm0.5)^\circ$K for β-MnS (wurtzite). In the case of α-MnS difficulty occurs, using g=2, because general arguments show that it is not possible to fit the experimental susceptibility. A fit can be obtained with g=1.8, but as this is an arbitrary assumption it seems that a full understanding of the properties of α-MnS must await further experiments.

NUCLEAR ORIENTATION IN ANTIFERROMAGNETIC SINGLE CRYSTALS. See Abstr. 3585

Magnetic Resonances

3921 A CONTRIBUTION TO THE THEORY OF RELAXATION OF THE MAGNETIC MOMENT IN FERROMAGNETICS. V.G.Bar'yakhtar and S.V.Peletminskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 651-6 (Sept., 1960). In Russian.

Considers relaxation of the magnetic moment in a ferromagnetic It is shown that, due to the sd exchange interaction between spin waves and conduction electrons, a quasi-equilibrium distribution of spin waves and conduction electrons is first established with a non-equilibrium value of the projection of the magnetic moment on the axis of easiest magnetization. Then, due to weak relativistic spin–orbit interaction, an equilibrium value of this projection is gradually established. The relaxation time of the projection is independent of temperature and is of the order of 10^{-8}-10^{-9} sec. [English translation in: Soviet Physics–JETP (USA)].

3922 MAGNETIC RELAXATION IN FERROMAGNETIC METALS.
L.L.Buishvili, G.R.Khutsishvili and O.D.Cheishvili.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 726-36 (Sept., 1960). In Russian.

Gives a microscopic calculation of magnetic relaxation due to s–d exchange interaction in ferromagnetics. Expressions are derived for the kinetic coefficients. A general phenomenological analysis of the problem is carried out by taking into account "direct" relaxations. [English translation in: Soviet Physics–JETP (USA)].

3923 FERROMAGNETIC RESONANCE IN Ni–Cd FERRITE SYSTEM AT MICROWAVE FREQUENCIES. S.Takemoto.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 153-62 (Sept., 1959).

Ferromagnetic resonance experiments on spherical polycrystalline specimens of the Ni–Cd ferrite system $Ni_{1-x}Cd_xFe_2O_4$ at frequencies of 9700 and 24 000 Mc/s were performed at room temperature. The experimental method is described and the variations of the g-factor (g), line-width (ΔH), damping constant (λ), and relaxation time (T), as functions of composition are discussed. The results show that the values of the effective g-factor are from 2.15 to 2.00 and those of the internal field are from 260 Oe to about zero, and it was also found that in the magnetic region $0 \leq x \leq 0.7$, $3.0 \times 10^{-10} < T < 10 \times 10^{-10}$ sec, $0.3 \times 10^8 < \lambda < 1.4 \times 10^8$ rad/sec, and $130 < \Delta H < 330$ Oe at 9700 Mc/s; and $1.9 \times 10^{-10} < T < 5.0 \times 10^{-10}$ sec, $0.20 \times 10^8 < \lambda < 1.1 \times 10^8$ rad/sec, and $230 < \Delta H < 600$ Oe at 24000 Mc/s.

3924 MAGNETIC RESONANCE IN $Ti_mMg_nFe_{3-m-n}O_4$ FERRITES AND THEIR MAGNETIZATION. T.Nakau.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 241-56 (Sept., 1959).

The ferromagnetic resonance absorption and the magnetization were measured on two natural singie crystal samples of $Ti_mMg_nFe_{3-m-n}O_4$ ferrites (m = 0.51, n = 0.075, Curie point = = 125° C; and m = 0.50, n = 0.072, Curie point = 135° C), from room temperature to −195° C. Each saturation magnetization obtained from magnetization measurement showed a broad maximum similar to those of Néel's P-type ferrites. The effective g-value and the magnetocrystalline anisotropy constant were obtained from resonance absorption experiments at the frequency of 25 700 Mc/s. Each effective g-value showed a remarkable temperature dependence, corresponding to the above-mentioned feature of the magnetization. The magnetocrystalline anisotropy constant (first order anisotropy constant) changed with temperature in a somewhat similar manner to magnetite, in agreement with the data on the magnetization. The anisotropy constant of one sample changed its sign at −155° C and that of the other at −133° C, and the direction of easy magnetization changed from the [111] to [100] direction with the decrease of temperature. These phenomena are discussed.

3925 MAGNETIC RESONANCE AND MAGNETOCRYSTALLINE ANISOTROPY IN YTTERBIUM IRON GARNET.
R.F.Pearson and R.W.Teale.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 308-10 (Aug., 1960).

Below about 200° K the values of the resonant field H_r and the line-width ΔH become markedly anisotropic. H_r decreases and ΔH increases with decreasing temperature for most orientations of H_r in a (110) plane, the maximum changes occurring for H_r in the [111] direction. The effect may be due to anisotropy of the exchange interaction between the ytterbium and iron sub-lattices.

E.F.W.Seymour

3926 RELAXATION OF THE MAGNETIC MOMENT IN AN ANTIFERROMAGNETIC DIELECTRIC. G.I.Urushadze.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 680-3 (Sept., 1960). In Russian.

The relaxation time of the magnetic moment of an antiferromagnetic dielectric is computed for the case when the non-equilibrium magnetic moment is perpendicular to the crystal axis. It is shown that at temperatures which satisfy a certain condition the relaxation time is inversely proportional to temperature. [English translation in: Soviet Physics–JETP (USA)].

3927 PARAMAGNETIC LATTICE RELAXATION TIME FOR SALTS OF PARAMAGNETIC IONS IN THE S-STATE.
Sh.Sh.Bashkirov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 577-85 (1958). In Russian.

A theoretical study of Mn(II), Fe(III), Gd(III) and Eu(II) salts. Direct and second-order processes are considered. The effect of the hyperfine structure of the energy level on electronic relaxation is calculated. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 4, 1-8 (1958)].

3928 EXPLANATION OF SOME "FORBIDDEN" TRANSITIONS IN PARAMAGNETIC RESONANCE.
B.Bleaney and R.S.Rubins.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 103-12 (Jan., 1961).

The abnormal intensity of some "forbidden" hyperfine transitions in the paramagnetic resonance spectra of ions with S = 1 or more is shown to be due to cross terms in the spin Hamiltonian. These arise from off-diagonal terms in the electronic and nuclear interaction, and the computed transition intensities agree closely with measurements on vanadium fluosilicate. In a powder in apparent doubling of the hyperfine transitions is shown to be due to the combined effect of these terms and others due solely to the electronic splitting.

3929 INVESTIGATION OF PARAMAGNETIC RELAXATION IN MAGNETICALLY DILUTE SYSTEMS. K.P.Sitnikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 521-6 (Sept., 1960). In Russian.

The internal magnetic field H_i and the splitting δ are computed for some paramagnetics from the measured values of the specific heat of the spin system, b, and its electric component b_e. It is demonstrated experimentally that magnetic dilution can be used to separate out effects on specific heat of the interaction of magnetic ions and with electric and magnetic fields of the crystal. It is also shown that the spin–lattice relaxation time depends on the concentration of magnetic ions in a paramagnetic. English translation in: Soviet Physics–JETP (USA)].

3930 ADDITIONAL SPIN RESONANCE SPECTRUM IN ANTIMONY-DOPED GERMANIUM.
R.W.Keyes and P.J.Price.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 473-4 (Nov. 15, 1960).

In addition to the resonance of electrons bound to antimony donors, Pontinen and Sanders (Abstr. 1267 of 1961), observed a set of four lines each of which apparently represents a g-tensor of the type observed by Wilson and Feher [Bull. Amer. Phys. Soc., Vol. 5, 60 (1960)] for electrons bound to donors in germanium subjected to a large elastic shear strain. The authors believe that this additional resonance may be accounted for by the strains normally present in germanium crystals, and present their reasons for this view.

J.M.Baker

3931 PROTON MAGNETIC RESONANCE STUDY OF BARIUM BROMATE MONOHYDRATE.
A.A.Silvidi and J.W.McGrath.
J. chem. Phys. (USA), Vol. 33, No. 6, 1789-90 (Dec., 1960).

The proton magnetic resonance absorption spectrum of barium bromate monohydrate was obtained using a Pound–Watkins spectrometer. Results indicate that there is only one orientation of the water molecule in the crystal. The p–p distance is 1.61 ± 0.01 A and direction angles of the p–p vector are $\alpha_0 = 30°$, $\beta_0 = 95°$, and $\gamma_0 = 122°$. The experimental errors in these angles were ±3°. Apparently the water molecule is oriented so as to form the complex, $O_{II}Br- -H-O--H- -O_{II}Br$, where O_{Br} are neighbouring bromate oxygens. Results obtained for barium chlorate monohydrate were consistent with those for barium bromate monohydrate.

3932 PARAMAGNETIC RESONANCE ABSORPTION IN BROMINE AND CHLORINE.
J.S.M.Harvey, R.A.Kamper and K.R.Lea.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 979-84 (Dec., 1960).

The microwave Zeeman spectra of atomic chlorine and bromine were observed. From measurements on several lines in the spectrum of the $^2P_{3/2}$ ground level, the electronic g-factors were found to be

$$g_J(Br) = 1.333921 \pm (5 \times 10^{-6})$$
$$g_J(Cl) = 1.333927_5 \pm (3 \times 10^{-6}).$$

An estimate of relativistic and diamagnetic corrections to the g-factors, based on self-consistent field wave-functions, was in satisfactory agreement with the experimental results. A comparison is made with the g-factors of fluorine and iodine.

3933 PARAMAGNETIC RESONANCE SPECTRUM OF DYSPROSIUM IN THE CUBIC FIELD OF CALCIUM FLUORIDE. W.Low.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 307-8 (Aug., 1960).

A single isotropic line due to Dy^{3+}, with a half-width of 30 G and $g = 7.47 \pm 0.03$, was observed at 20^0 K. It was inferred that the lowest energy level of the ion is a doublet, so that the ion is not suitable for a three-level maser. E.F.W.Seymour

3934 SPIN HAMILTONIAN OF Co^{2+}. F.S.Ham, G.W.Ludwig, G.D.Watkins and H.H.Woodbury.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 468-70 (Nov. 15, 1960).

Experimental results on the e.s.r. of Co^{2+} in crystals of CaF_2, ZnS, CdTe and ZnSe are reported which require for their explanation the augmentation of the usual spin Hamiltonian by terms such as $u\beta S_z^3 H_x$ and $US_z^3 I_x$. There is also an elementary derivation showing that one can predict the correct order of magnitude of the new terms from interactions with excited states. Typical values of u and U for CdTe are 0.0016 and 0.85×10^{-4} cm^{-1} respectively. J.M.Baker

3935 RESOLVED HYPERFINE SPECTRA OF ELECTRON-SPIN PARAMAGNETIC RESONANCE IN IRRADIATED LiF. Y.W.Kim, R.Kaplan and P.J.Bray.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 4-6 (Jan. 1, 1961).

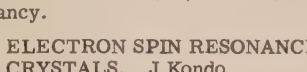
Evidence is presented supporting the view that the hyperfine structure observed in the e.s.r. spectra of irradiated LiF cannot be ascribed simply to the presence of F-centres in the crystals. The crystals investigated were exposed to 40 kV X-rays, thermal neutrons or γ-rays over a large range of doses. The results suggest that there are two types of paramagnetic centre present: one is probably an F-centre, and the other may consist of some impurity paramagnetic ion occupying possibly the F^- vacancy or perhaps the Li^+ vacancy. J.M.Baker

3936 ELECTRON SPIN RESONANCE OF Mn^{++} ION IN IONIC CRYSTALS. J.Kondo.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 106-14 (Jan., 1960).

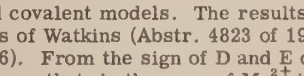
Fine structure constants of Mn^{2+} ion are calculated by using overlap and covalent models. The results are compared with the experiments of Watkins (Abstr. 4823 of 1959) and of Tinkham (Abstr. 8312 of 1956). From the sign of D and E determined experimentally, it can be shown that, in the case of Mn^{2+} in alkali chlorides, covalency is dominant, while in the case of Mn^{2+} in ZnF_2 the overlap effect predominates. It is also shown in each case that this model gives a correct order of magnitude of fine structure constants. The model also accounts for the fact that the magnitudes of D increase from LiCl to KCl.

3937 ELECTRON SPIN RESONANCE IN A GAMMA-IRRADIATED SINGLE CRYSTAL OF L-CYSTINE DIHYDROCHLORIDE. Y.Kurita and W.Gordy.
J. chem. Phys. (USA), Vol. 34, No. 1, 282-8 (Jan., 1961).

The electron spin resonance of a gamma-irradiated single crystal of L-cystine dihydrochloride,



was measured at 9 and 24 kMc/s for various orientations of the crystal in the magnetic field. The resonance pattern was found to be a doublet, the spacing between the components of which is independent of the crystal orientation as well as of the strength of the static magnetic field. The spectroscopic splitting factor was found to be anisotropic with the principal values: $g_u = 2.003$, $g_v = 2.025$, and $g_w = 2.053$. A model of the free radical



in which the electron spin density is mainly concentrated in a non-bonding 3 p orbital of the sulphur atom, is proposed. The model accounts very well for the principal values of the g tensor as well as their directions relative to the atomic configuration. It also can give rise to the observed proton hyperfine structure.

3938 ELECTRON SPIN RESONANCE IN COMPLEXES OF AROMATIC HYDROCARBONS WITH IODINE. L.S.Singer and J.Kommandeur.
J. chem. Phys. (USA), Vol. 34, No. 1, 133-40 (Jan., 1961).

Accurate measurements of electron spin concentration in semiconducting molecular complexes of perylene and pyrene with iodine indicated an exponential temperature dependence in excellent agreement with the activation energy for electronic conduction. The agreement of the magnitudes of the spin concentrations with the carrier concentration estimates obtained from electrical measurements further confirms the identification of the unpaired spins as charge carriers. At low temperatures, small temperature-independent concentrations of trapped spins or free radicals are observed. Spin resonance line shapes, relaxation times, and g-factor anisotropies also were determined.

3939 ELECTRON SPIN RESONANCE LINE SHAPE OF A POLYCRYSTALLINE CH RADICAL. R.Lefebvre.
J. chem. Phys. (USA), Vol. 33, No. 6, 1826-9 (Dec., 1960).

A formula is derived for the electron spin resonance line shape of a polycrystalline sample containing the CH π-electron radical. The assumption is made in this derivation that the spectrum of the radical in a specific orientation is made up of Gaussians. The line shapes are calculated at the X, K, and J bands, and shown to be rather different for a sufficiently small component line width.

3940 CROSS SPIN RELAXATION IN THE HYPERFINE STRUCTURE OF THE ELECTRON SPIN RESONANCE OF Co^{2+} IN CORUNDUM. G.M.Zverev and A.M.Prokhorov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 545-7 (Sept., 1960). In Russian.

Cross spin relaxation was detected on the hyperfine structure of the paramagnetic resonance of the Co^{2+} ion in corundum. The cross relaxation time, T_{12}, was measured and found to be 0.27 sec and independent of temperature. [English translation in: Soviet Physics—JETP (USA)].

3941 CROSS RELAXATION AND CONCENTRATION EFFECTS IN RUBY. R.W.Roberts, J.H.Burgess and H.D.Tenney.
Phys. Rev. (USA), Vol. 121, No. 4, 997-1000 (Feb. 15, 1961).

Cross relaxation effects in ruby maser crystals are treated by introduction of a cross relaxation probability in the rate equations. Detailed solutions are obtained for several specific processes and compared to recent experiments. It is shown that cross relaxation can improve maser performance even in the absence of impurity doping. Pulse experiment at 0.06 and 0.14% chromium ion concentrations in a ruby travelling-wave maser are interpreted in terms of a five-spin process in addition to a four-spin process.

ELECTRON SPIN RESONANCE OF THE A-CENTRE IN IRRADIATED SILICON. See Abstr. 3656

3942 ANGULAR DEPENDENCE OF NUCLEAR SPIN—LATTICE RELAXATION TIME FOR SEVERAL ALKALI HALIDE CRYSTALS. E.R.Andrew, K.M.Swanson and B.R.Williams.
Proc. Phys. Soc. (GB), Vol. 77, Pt 1, 36-48 (Jan., 1961).

The anisotropy of relaxation time for both F^{19} and Li^7 was examined in a pure single crystal of lithium fluoride, and is satisfactorily accounted for in terms of Bloembergen's spin-diffusion theory of relaxation. Confirmation is provided by the reduced anisotropy observed in two single crystals of lithium fluoride containing enhanced concentrations (50% and 90%) of Li^6. The lack of anisotropy of the Na^{23} relaxation time found in sodium chloride accords with the predictions of the theories of quadrupolar relaxation. A similar observation for the Br^{79} and Br^{81} relaxation times in potassium bromide is not inconsistent with van Kranendonk's theory and suggests that covalency does not make a strong contribution to the quadrupolar relaxation process.

3943 A CONTRIBUTION TO THE THEORY OF NUCLEAR SPIN—LATTICE RELAXATION IN OCTAHEDRAL COMPLEXES. B.I.Kochelaev.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 257-8 (Aug., 1960). In Russian.

Deals with calculation of the nuclear spin—lattice relaxation times due to quadrupole interactions in XY_6 complexes, where X is the atom with relaxing spin. It is assumed that binding of the atoms with each other in the complex is stronger than with other atoms or ions in the crystal, as in cryolite (containing AlF_6 complexes) or in potassium alums (containing $Al(H_2O)_6$ complexes). [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 133-4 (Aug., 1960)]. A.Tybulewicz

3944 THE OVERHAUSER EFFECT AND RELATED PHENOMENA. G.R.Khutsishvili.
Uspekhi fiz. Nauk (USSR), Vol. 71, No. 1, 9-69 (May, 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 285-319 (Nov.-Dec., 1960).

A comprehensive article reviewing the principles involved in producing oriented nuclei by resonance methods making use of the interaction of the nuclear spins with uncompensated electron spins. Sections are devoted to the Overhauser effect in metals, diamagnetic liquids and solids containing paramagnetic impurities, paramagnetic salts, and semiconductors; to the method of induced dynamic polarization; and to non-stationary methods. Experimental results published up to 1959 are discussed. 98 references.

E.F.W.Seymour

3945 ORIGIN OF THE LINE WIDTH IN THE NUCLEAR RESONANCE OF FERROMAGNETIC METALS.
J.Friedel and P.G.de Gennes.
C.R. Acad. Sci. (France), Vol. 251, No. 13, 1283-5 (Sept. 26, 1960). In French.

The line width observed in the Portis experiment is explained as due to variations of the demagnetizing field at the specimen surface. E.P.Wohlfarth

NUCLEAR MAGNETIC RESONANCE IN SUPERCONDUCTING TIN. See Abstr. 2922

NUCLEAR RESONANCE ABSORPTION OF ULTRASOUND IN KI AND KBr. See Abstr. 3597

3946 MAGNETIC RESONANCE IN IONIC CRYSTALS OF NUCLEI OF IRON GROUP ELEMENT ATOMS.
K.A.Valiev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 5, 769-75 (1958). In Russian.

The possibility is examined of observing the n.m.r. of paramagnetic atoms in magnetically dilute crystals of salts of iron group elements. It is found that, at temperatures of $1^{\circ}K$ and over, the width of the nuclear resonance line is determined by the probabilities of electron relaxation transitions. Hence, direct observation of nuclear resonance on paramagnetic atoms is possible only at liquid helium temperatures. The probabilities of relaxational transitions between the hyperfine sublevels of the ions V^{3+} (S = 1) and Cr^{3+} (S = 3/2) are calculated. These are 10^{-5} and 10^{-4} of the probabilities of electron transitions for the V^{3+} and Cr^{3+} ions respectively. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 5, 6-10 (1958)].

3947 THE EFFECT OF LATTICE DEFECTS IN SILVER BROMIDE ON THE BROMINE NUCLEAR RESONANCE.
G.Seifert.
Z. Phys. (Germany), Vol. 161, No. 2, 132-49 (1961). In German.

An investigation of the broadening of the Br^{79} and Br^{81} nuclear resonance lines in doped AgBr as split by quadrupole interaction and T_1-broadened by field gradients caused by Ag vacancies, Ag ions, etc. A variety of effects is observed for various doping atoms including Ca, Pb, S, Li, Na and Cu. The effect of concentration, annealing, temperature in the range 150 - $300^{\circ}K$ and of time on the intensity of the observable central line is investigated in some detail. The results are used to obtain information about the type of defect and its diffusive motion. J.G.Powles

3948 THE EFFECT ON THE SPIN—LATTICE RELAXATION TIME IN IONIC CRYSTALS OF THE NUCLEAR QUADRUPOLE INTERACTION. I.Ebert and G.Seifert.
Z. Phys. (Germany), Vol. 161, No. 2, 150-62 (1961). In German.

A calculation of the spin lattice relaxation time in ionic crystals due to nuclear quadrupole interactions which generalizes a calculation of Reif (Abstr. 1741 of 1956) to include the effect of static as well as fluctuating field gradients. The calculations are carried out in detail for I = 3/2 and applied to the interpretation of results on doped silver bromides (see preceding abstract).

J.G.Powles

3949 THE KNIGHT SHIFT IN ALLOYS.
W.G.Henry.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 989-93 (Dec., 1960).

It is pointed out that considerations regarding the heats of solution of alloys suggest that the number of units of electronic charge accumulated round a polyvalent solute atom in a monovalent solvent is usually greater than the excess valency. The additional charge transfer requires a reduction in the magnitude of the electronic wave-functions at solvent nuclei, and hence leads to a reduction in the Knight shift, as has been observed for silver alloys.

E.F.W.Seymour

3950 N.M.R. MEASUREMENTS OF THE KNIGHT SHIFT IN CONDUCTING PbO_2. D.A.Frey and H.E.Weaver.
J. Electrochem. Soc. (USA), Vol. 107, No. 11, 930-2 (Nov., 1960).

N.M.R. measurements on samples prepared in different ways and with different crystal symmetry indicate that the resonance exhibits a Knight shift characteristic of a conductor. The Knight shift decreases as decomposition is produced by heating the specimen. E.S.R. measurements on the samples were inconclusive and no superconducting transition was observed in β-PbO_2 down to $1^{\circ}K$. J.M.Baker

3951 PROTON RESONANCE IN THE ANTIFERROMAGNETIC STATE OF $NiCl_2.6H_2O$ AND $CoCl_2.6H_2O$. T.Sugawara.
J. Phys. Soc. Japan, Vol. 14, No. 9, 1248 (Sept., 1959).

3952 PROTON MAGNETIC RESONANCE STUDY OF CRYSTALLINE POTASSIUM TRISOXALATO-RHODIUM (III) HYDRATE. A.L.Porte, H.S.Gutowsky and G.M.Harris.
J. chem. Phys. (USA), Vol. 34, No. 1, 66-71 (Jan., 1961).

The broad-line proton magnetic resonance spectrum of crystalline potassium trisoxalatorhodium (III) hydrate, $K_3Rh(C_2O_4)_3 4\frac{1}{2}H_2O$, was investigated in the temperature range $77^{\circ}K$-$330^{\circ}K$. The spectrum at $77^{\circ}K$ indicates that some of the protons in the crystal are not present in water of crystallization and an analysis of this same spectrum indicates that the compound should be formulated as

$$K_6[Rh(C_2O_4)_3][Rh(C_2O_4)_2(HC_2O_4)(OH)]8H_2O.$$

This formula is not inconsistent with the chemical reactions that the compound undergoes, and it explains some properties which are not satisfactorily accounted for by the previously accepted formula

$$K_3[Rh(C_2O_4)_3]4\tfrac{1}{2}H_2O.$$

The absorption spectrum at $318^{\circ}K$ substantiates the analysis of the spectrum at $77^{\circ}K$ and it also indicates that the water of crystallization can be grouped into at least three sets, the water molecules in different sets having different degrees of mobility. The proton magnetic resonance data also indicate that the "monohydrate", $K_3Rh(C_2O_4)_3H_2O$, is probably $K_6[Rh(C_2O_4)_3][Rh(C_2O_4)_2(HC_2O_4)(OH)]H_2O$

3952 PROTON SPIN POLARIZATION OF WATER ADSORBED ON SUCROSE CHARS. J.J.Krebs.
J. chem. Phys. (USA), Vol. 34, No. 1, 326-9 (Jan., 1961).

By saturating forbidden electron-nuclear double transitions in paramagnetic materials, it is possible to considerably enhance the nuclear polarization in a positive or negative sense. This effect was investigated experimentally using the protons of water adsorbed on paramagnetic charred sucrose. The dependence of the enhancement on the saturating microwave power is derived for the case of overlapping allowed and forbidden transitions, and predicts a linear change in polarization at low power levels. The general features of the enhancement found are in agreement with those predicted by perturbation theory using a simple dipole-dipole electron-nuclear interaction. However, the plot of log (polarization change) versus log (power) has a slope of 0.82 ± 0.04 instead of 1.0. In addition, the field separation between the points of maximum positive and maximum negative enhancement is too small in those chars for which inhomogeneous broadening is suspected.

MECHANICAL PROPERTIES OF SOLIDS

3954 ELASTIC CONSTANTS OF SINGLE CRYSTALS OF THE B.C.C. TRANSITION ELEMENTS V, Nb, AND Ta.
D.I.Bolef.
J. appl. Phys. (USA), Vol. 32, No. 1, 100-5 (Jan., 1961).

Values of the elastic constants are reported at T = $27^{\circ}C$. They are, in units of 10^{11} d/cm^2:

	c_{11}	c_{12}	c_{44}
V	22.8	11.9	4.26
Nb	24.6	13.4	2.87
Ta	26.7	16.1	8.25

Comparisons are made of the values obtained for two crystals each

of V and Ta. A high-frequency c.w. resonance technique was used in these measurements. The shear anisotropies $A = 2c_{44}/(c_{11}-c_{12})$ are anomalously small for these elements as compared to other cubic system elements. An analysis of the shear anisotropy, based on Fuchs' model, is given. It is found essential in this analysis to take into account next-nearest as well as nearest-neighbour ion—ion interactions.

3955 DISLOCATION CONTRIBUTIONS TO THE MODULUS AND DAMPING IN COPPER AT MEGACYCLE FREQUENCIES. G.A.Alers and D.O.Thompson.
J. appl. Phys. (USA), Vol. 32, No. 2, 283-93 (Feb., 1961).

The three elastic moduli of 99.999+% pure copper and their associated internal frictions were measured between 4.2° and 250° K both before and after fast neutron bombardment. The changes produced by the irradiation were used to determine the dislocation contributions to the damping and moduli as a function of frequency and temperature. The dislocation damping showed the maximum predicted by Granato and Lücke (Abstr. 6970 of 1956; 420 of 1958) to arise from the heavily damped bowing of dislocation loops. By calculating the resolved shear stress factors and measuring the dislocation density by etch pit counts, it was possible to determine the coefficient B which describes the viscous drag on a moving dislocation as well as the effective loop length l. The factor B was found to be 8×10^{-4} dyn sec/cm^2 at 300° K and to decrease linearly with decreasing temperature, as predicted by Leibfried. The effective loop length appeared temperature independent and had a value of 3×10^{-4} cm in the sample examined most carefully. Cold-worked single crystals of the same copper were also studied. Two Bordoni-type peaks in the damping—temperature curves were located at 135° and 60° K at 10 Mc/s. Activation energies of 0.113 and 0.05 eV were determined by using low-frequency data taken from the literature.

3956 TECHNIQUE FOR MEASURING THE ELASTIC PROPERTIES OF BITUMENS, TARS AND SOILS UNDER DYNAMIC LOADING. E.N.Thrower.
J. sci. Instrum. (GB), Vol. 38, No. 3, 69-73 (March, 1961).

A technique is described for the measurement of the components of the complex (dynamic) Young's modulus (E*) and the complex rigidity modulus (G*) of bitumens, tars and soils under sinusoidal loading. The equipment is capable of measuring the complex Young's modulus up to about $|E^*| = 5 \times 10^{10}$ dyn/cm^2 (10^6 lb/in.^{2}) and the complex rigidity modulus up to $|G^*| = 2 \times 10^{10}$ dyn/cm^2 (3×10^5 lb/in.^{2}) over the frequency range 5 to 500 c/s and at temperatures between −20 and +30° C. To measure the complex Young's modulus, an axial sinusoidally varying force is applied to a cylindrical specimen by a moving-coil vibrator. Piezoelectric gauges are used to convert the force applied to the specimen, and the displacement of its driven end, into voltages, which are measured on a phase-sensitive voltmeter. The complex modulus is derived from a comparison of these voltages with those obtained using a steel calibration spring. For the measurement of the complex rigidity modulus, the material is sheared in the annulus between two cylinders, the inner being driven by the vibrator. The same two gauges now serve to measure the force applied to the inner cylinder, its displacement and their relative phase.

3957 INFLUENCE OF HYDROSTATIC PRESSURE ON THE ELASTIC PROPERTIES OF CERIUM.
F.F.Voronov, L.F.Vereshchagin and V.A.Goncharova.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 5, 1104-7 (Dec. 11, 1960). In Russian.

Measurements were made of the transmission times of 3.5-5.5 Mc/s ultrasonic waves through cerium specimens over the pressure range 0-10 000 kg/cm^2. The following quantities were calculated from the transmission times: longitudinal and transverse wave velocities; bulk, shear and Young's moduli; Poisson's ratio; Debye temperature. All properties showed discontinuities at pressures between 6000 and 8000 kg/cm^2, corresponding to a first-order phase transition. [English translation in: Soviet Physics—Doklady (USA)]. R.F.S.Hearmon

3958 ELASTIC BEHAVIOUR OF MATTER UNDER VERY HIGH PRESSURES — UNIFORM COMPRESSION.
S.Bhagavantam and E.V.Chelam.
J. Indian Inst. Sci., Vol. 42, No. 3, 29-40 (July, 1960).

The effective elastic constants are evaluated from the expression for the strain energy, utilizing the theory of non-linear elasticity. The initial finite deformations are assumed to be of general type and a general infinitesimal deformation is superimposed. The effective elastic constants are then derived in terms of the second- and third-order elastic constants of the substance in the stress-free condition. Values are given to these components, and the effective elastic constants are derived appropriate to a triaxial strain, a uniaxial strain and a shear. The substance is assumed to possess initial cubic symmetry. Results are given for the simple case of cubic compression. A.C.Whiffin

3959 ELASTIC BEHAVIOUR OF MATTER UNDER VERY HIGH PRESSURES — SIMPLE SHEAR. E.V.Chelam.
J. Indian Inst. Sci., Vol. 42, No. 3, 41-6 (July, 1960).

This paper follows on from that by Bhagavantam and Chelam (see preceding abstract) which was restricted to cases where the Jacobian matrix was symmetrical, whereas that in which shear is considered would be unsymmetrical. The material is assumed to have cubic symmetry and its equations for strain energy per unit volume are derived. The increase due to additional deformation is then determined. The effective elastic constants are obtained as in the case of uniform compression. A.C.Whiffin

3960 ELASTIC BEHAVIOUR OF MATTER UNDER VERY HIGH PRESSURES — CONSIDERATIONS OF INSTABILITY.
E.V.Chelam.
J. Indian. Inst. Sci., Vol. 42, No. 4, 101-7 (Oct., 1960).

Previous papers in this series (see preceding abstract) dealt with the development of equations for the effective elastic constants based on the effective energy. The present paper shows that the expression for effective energy is definite and indicates elastic stability. Because the coefficients in this energy expression have been calculated, the theoretical work already completed provides an approach for determining the elastic instability in any system subjected to large strains. A.C.Whiffin

3961 INTERNAL FRICTION IN FIBRE ASSEMBLIES.
J.D.Huffington.
Brit. J. appl. Phys., Vol. 12, No. 3, 99-102 (March, 1961).

Experiments have been carried out to measure the energy dissipated as internal friction (hysteresis loss or work of deformation) when sliding rectangular steel sliders on various types of fibre assembly. The theoretical assumptions previously made by Greenwood and Tabor in explaining experiments with steel balls sliding on rubber lead to predictions of internal friction in fibre assemblies which are too low. It is thought that one reason for this is the tendency for the pressure to build up at the front edge of the slider when it moves over a fibre assembly, thus increasing the amount of internal friction corresponding to a given deformation. It has also been found that the energy dissipated appears to be abnormally high for staple yarns as compared with continuous filament yarns. It is suggested that two mechanisms of energy dissipation exist. On the one hand there is the normal mechanism where deformation is subject to complete elastic recovery, although energy is lost in the process. In addition, with staple yarns in particular, work of internal rearrangement may occur which is not subject to elastic recovery, but which represents a permanent change in the yarn. It is suggested that this may be a wear or abrasion factor due to general sliding and loosening of fibres within the yarn. A quantitative measure of this factor offers an approach to a definition of abradability or liability to wear.

3962 TEMPERATURE DEPENDENCE OF INTERNAL FRICTION OF PURE NICKEL.
O.I.Datsko and V.A.Pavlov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 5, 900-4 (1958). In Russian.

The results of measurements on recrystallized pure Ni are reported. Two peaks of internal friction were found to exist. The first peak (440-460° C) is associated with the viscous properties of the grain boundaries; the second (630-800° C), with stress relaxation along the mosaic block boundaries. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 5, 122-6 (1958)].

3963 ON THE INTERNAL FRICTION OF COLD-WORKED AND QUENCHED MARTENSITIC IRON AND STEEL.
T.Mura, I.Tamura and J.O.Brittain.
J. appl. Phys. (USA), Vol. 32, No. 1, 92-6 (Jan., 1961).

A theoretical explanation is given for the internal friction peaks which are observed at 200° ~ 250° C for cold-worked iron and steels in the martensitic condition. The theory for the peaks is based upon the addition of a term to the free energy in order to account for the strain energy due to the interaction of an atmosphere and the

line imperfections. The standard linear solid was obtained from the model in which dislocations are vibrating with an atmosphere of carbide precipitates.

3964 SECOND DISLOCATION RELAXATION PEAK IN ALUMINIUM AT LOW TEMPERATURES. G.S.Verma.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 412-14 (Sept., 1960).

The frequency–temperature dependence of the second relaxation peak in aluminium was measured and used to estimate an activation energy of 0.024 eV. This activation energy is used to calculate the ratio τ_p^0/μ, where τ_p^0 is the Peierls stress and μ is the shear modulus. In order to deduce a value for this ratio that is comensurate with Cottrell's estimate, it is necessary to use the model for dislocation motion proposed by Lothe and Hirth (Abstr. 13782 of 1959); in this model the motion is controlled by the nucleation and growth of kinks in the dislocation which lie in Peierls potential troughs. With this model it is found that $\tau_p^0/\mu = 1.144 \times \times 10^{-4}$. R.Bullough

3965 PHENOMENOLOGICAL ELASTOMECHANICAL BEHAVIOR OF RUBBERS OVER WIDE RANGES OF STRAIN. A.J.Carmichael and H.W.Holdaway.
J. appl. Phys. (USA), Vol. 32, No. 2, 159-66 (Feb., 1961).

Relationships are developed which permit a relatively good description of the elastomechanical behaviour of natural rubbers over the full range of deformations. These relationships are obtained by development of a general relationship set forth by Mooney (1940). A stress function is obtained from which principal stresses may be evaluated for any given set of compatible strains. This theory is tested by applying it to experimental results of Treloar. It is demonstrated that by the insertion of relatively simple "exponential type" functions, a very good fit is obtained over the whole range of Treloar's data. In this form, the properties of natural rubber can be described by three parameters, A, B, and β. It is found that there are unique relationships between A and β, B and β, and between β and rubber hardness for a range of natural rubbers from pure gum vulcanizates to the hardest of commercial natural rubbers.

3966 EQUATIONS OF NONLINEAR ELASTICITY THEORY IN THE DISPLACEMENTS. L.A.Tolokonnikov.
Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 6, 815-22 (1957). In Russian.

Using Novozhilov's formulation for the strains, the stress–strain relation for a nonlinear body is obtained in tensor-invariant form. The equation is considered with special reference to the experimental results of Davis (1945). R.F.S.Hearmon

3967 RADIOGRAPHIC STRESS MEASUREMENTS ON HARDENED STEEL. I. DETERMINATION OF THE MACROSTRESSES. H.Neff.
Arch. tech. Messen (Germany), No. 298 (Ref. V 1286-14), 229-32 (Nov., 1960). In German.

When a specimen of steel is subjected to uniaxial stress, it is assumed that at the surface of the test piece, which is the only part of the specimen which can be studied by X-rays, the stress normal to the surface is negligibly small and the only important stress components are those in the plane of the surface. The diffraction which will result from such stresses (or strains) when reflected X-rays are employed has been studied mathematically and some results are given of the application of the technique to studies of the macrostresses produced in hardened steel. A.C.Whiffin

3968 YIELDING AND WORK-HARDENING IN ALPHA-BRASSES. P.J.Feltham and G.J.Copley.
Acta metallurgica (Internat.), Vol. 8, No. 8, 542-50 (Aug., 1960).

The tensile yield stress σ_y of polycrystalline α-brasses containing up to 35% of zinc, recrystallized at 800°C and strained in the range 77-291°K, was found to vary with temperature and composition as the resolved shear stress with $\tau_y/\sigma_y \cong \frac{1}{3}$. Linear hardening, at a rate of about G/20, terminates at a tensile stress $\sigma_c(T)$; parabolic hardening above σ_c is ascribed to the spreading of slip from glide zones in which small numbers of dislocations are confined by Cottrell–Lomer barriers. The pronounced increase of σ_y and σ_c with rising zinc content or decreasing temperature is interpreted in terms of changes in the Peierls–Nabarro force resulting from the diminution of the core widths of partial dislocations; a major part of the increase of σ_c appears however to be associated with the steady decline of the stacking fault energy as the α–β phase boundary is approached.

3969 A STUDY OF ELONGATION AND AGEING IN Al–4%Cu AND Al–4%Cu–0.05%In CRYSTALS. J.M.Silcock.
Acta metallurgica (Internat.), Vol. 8, No. 9, 589-97 (Sept., 1960).

The relation between deformation characteristics and θ' nucleation was studied in Al–4% Cu and Al–4% Cu–0.05% In crystals. Preferred nucleation of θ' occurs in the orientations which do not contain the slip direction in the $(100)_{\theta'}$ plane. This is attributed to the atomic configuration at the edges of partial dislocations. Deformation of aged crystals showed that crystals hardened by G.P.[1] at 130°C show characteristics similar to those of "as quenched" crystals. The slip lines are fainter and fewer when G.P.[2] zones are present, and are not detected at all until heavy deformations when large quantities of θ' are present. This is attributed to different hardening mechanisms.

3970 CRITERIA FOR YIELDING OF DISPERSION-STRENGTHENED ALLOYS. G.S.Ansell and F.V.Lenel.
Acta metallurgica (Internat.), Vol. 8, No. 9, 612-16 (Sept., 1960).

A dislocation model is presented in order to account for the yield behaviour of alloys with a finely dispersed second-phase. The criteria for yielding used in the model is that appreciable yielding occurs in these alloys when the shear stress due to piled-up groups of dislocations is sufficient to fracture or plastically deform the dispersed second-phase particles, relieving the back stress on the dislocation sources. Equations derived on the basis of this model predict that the yield stress of the alloys varies as the reciprocal square root of the mean free path between dispersed particles. Experimental data is presented for several SAP-type alloys, precipitation-hardened alloys and steels which are in good agreement with the yield strength variation as a function of dispersion spacing predicted by this theoretical treatment.

3971 INITIAL STAGES OF PLASTIC DEFORMATION IN COPPER AND ALUMINUM.
A.R.Rosenfield and B.L.Averbach.
Acta metallurgica (Internat.), Vol. 8, No. 9, 624-9 (Sept., 1960).

The early stages of plastic flow and microcreep were studied in single crystals and in polycrystalline copper and aluminium using a method with a strain sensitivity of 2×10^{-6} in the temperature range –196 to 25°C. The temperature dependence of the 10^{-6} yield stress is interpreted as arising from a thermal activation of stacking faults under stress. This model results in a value of 25 ergs/cm^2 for the stacking fault energy of copper and 100 ergs/cm^2 for aluminium.

3972 DYNAMICAL EQUATION FOR A COMPRESSED PLASTIC MEDIUM. M.I.Éstrin.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 1, 36-9 (Nov. 1, 1960). In Russian.

Presents a variant of an approximation to the equation of plane deformation of a plastic medium, by postulating a linear relation:

$$(\dot{\epsilon}_x + \dot{\epsilon}_y) = \frac{1}{2K}(\dot{\sigma}_x + \dot{\sigma}_y),$$

(where ϵ and σ are the diagonal terms of stress and strain tensors respectively and K is a constant), rather than assuming the incompressibility condition. Obtains wave fronts and velocities of propagation of shear waves. [English translation in: Soviet Physics — Doklady (USA)].

3973 EFFECT OF AGING TIME AFTER CLEAVAGE ON THE PLASTICITY OF MgO SINGLE CRYSTALS. C.A.Stearns.
J. appl. Phys. (USA), Vol. 31, No. 12, 2317 (Dec., 1960).

The single crystals were tested in bending under four-point loading. Some were tested immediately after cleavage and were about 30 sec old, while others were aged in air for various times. The results show two phenomena: a size effect in which thinner specimens are more ductile than thicker ones, and a time effect in which ductility is reduced by ageing, with the greatest change occurring within 30 sec after cleavage. It is suggested that this variation in ductility could be obscured by the size effect and also would probably not be noted if a test were not made immediately after cleavage. This might account for some investigators reporting no change of ductility with time after cleavage. Explanations involving dislocations created by cleavage are advanced for both phenomena, but a surface reaction process is also considered as a plausible cause of the ageing effect. A.E.Kay

3974 POSSIBLE EVIDENCE FOR THE LIGHT INDUCED PLASTICITY IN GERMANIUM. M.Kikuchi and M.Saito.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1642 (Nov., 1959).

Bending a filament under infrared illumination decreases carrier lifetime at the point of stress. This could indicate an increased dislocation density arising from light induced plasticity.
C.D.Cox

3975 THE RELATION BETWEEN THE PLASTIC DEFORMATION OF ALUMINIUM SINGLE CRYSTALS AND POLYCRYSTALS. S.Howe and C.Elbaum.
Phil. Mag. (GB), Vol. 6, 37-48 (Jan., 1961).

Single crystals of ⟨100⟩, ⟨111⟩ and ⟨110⟩ axial orientation, and polycrystals, both of 99.99% pure aluminium, were deformed in tension at temperatures of 27° C, 200° C, 400° C and 600° C. The experiments on single crystals reveal that as the temperature is increased, the shear stress–shear strain curves for the three orientations become more and more similar until at 600° C they are identical. On the other hand, the surface appearance of the crystals strained at 600° C indicates that the mode of deformation depends drastically on orientation. Taylor's criterion for the comparison of the stress–strain curves of single and polycrystals was found to be valid at 27° C. As the temperature is raised, however, the criterion ceases to be applicable. From the results of these experiments it is proposed that at the lower temperatures in both single crystals and polycrystals the principal hardening mechanism is the formation of Lomer–Cottrell barriers that act as obstacles against which glide dislocations can pile up. As the temperature is raised these barriers become ineffective as obstacles to slip, whereas grain boundaries in polycrystals continue to be effective in causing dislocation pile-ups.

3976 THE THEORY OF PLASTICITY ALLOWING FOR RESIDUAL MICROSTRESSES.
Yu.I.Kadashevich and V.V.Novozhilov.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 78-89 (1958).
In Russian.

A residual stress tensor is defined in terms of the boundary between the elastic and plastic regions in the stressed material, and the form of the boundary established for a material in which the Bauschinger effect is ideal. Some models consisting of spring and friction elements are discussed to illustrate the equations governing the behaviour of the material. The equations are integrated to give load–deformation relations for a thin-walled tube with specified initial and residual stresses and subjected to additional tension and torsion, and for a thin walled tube initially extended in the plastic region and subjected to simultaneous tension and torsion. Comparison with the experimental results of Feigen (1954) and Budiansky et al. (1951) shows that the present theory gives better agreement than the flow theory or the theory of small plastic deformation.
R.F.S.Hearmon

3977 THE GENERAL EQUATIONS OF IDEAL PLASTICITY THEORY AND THE STATICS OF LOOSE MATERIALS.
D.D.Ivlev.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 90-6 (1958).
In Russian.

Assuming the Tresca–St Venant plasticity conditions and the associated law of flow, the general equations of ideal plasticity are derived and analysed. If the plastic stress state is such that it coincides with the edges of the Coulomb prism, the problem is statically determinate. The general equations of the statics of a loose material are also discussed under conditions such that the limiting stress state corresponds to the edges of the surface defining the limiting equilibrium in principal stress space. Under these conditions, this problem is also statically determinate.
R.F.S.Hearmon

3978 THE LAWS OF PLASTICITY FOR A MATERIAL WITH HARDENING. V.D.Klyushnikov.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 97-118 (1958). In Russian.

A review of proposed stress–strain relations in a hardening material, starting with the Hencky–Nadai law and tracing its development through the work of Ilyushin, Prager and others; the laws of slip are also reviewed. The discussion is mainly in terms of vector, tensor and invariant formulations. Large deformations, thermodynamics, time-dependent properties and boundary value problems are not considered.
R.F.S.Hearmon

PLASTIC FLOW IN SEMICONDUCTORS AND ITS EFFECTS ON ELECTRICAL PROPERTIES. See Abstr. 3735

CRITICAL TEMPERATURES FOR QUASI-ELASTICITY OF TRANSPARENT PLASTICS. See Abstr. 3820

3979 INVESTIGATION OF THE CREEP OF METALS AND ALLOYS. II. THE EFFECT OF THE REMOVAL OF DEFECTS ON THE KINETICS OF THE INITIAL STAGE OF THE CREEP OF METALS WITH A DEFORMED CRYSTAL LATTICE. Ya.E.Geguzin.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 5, 825-31 (1958). In Russian.

Samples of plastically-deformed Cu and electrolytic Cu were used. The experiments were carried out at constant rate of heating (maximum temperature ~1000° C) and in the load range 0.47-7 kg/cm². Back-reflection X-ray photographs of the samples were obtained at various stages during the treatment. The cause of the increased rate of creep observed is briefly discussed. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 5, 51-7 (1958)].

3980 INVESTIGATION OF DIFFUSION THROUGH BOUNDARIES ARISING IN THE PROCESS OF CREEP IN COPPER. Yu.P.Romashkin and L.M.Shestopalov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3029-39 (Dec., 1960).
In Russian.

Experiments on copper in compression are reported at strains up to 50%, temperatures between 400 and 900° C, and strain rates from 0 to 2000% per hour. The existence is established of a critical strain above which creep velocity increases sharply. Parallel experiments on the diffusion of silver in copper, and those on creep, are discussed in relation to the effect of creep on the formation of new grain boundaries and on the diffusion acceleration. See also following abstract. [English translation in: Soviet Physics–Solid State (USA)].
R.F.S.Hearmon

3981 THE THEORY OF DIFFUSION IN METALS UNDERGOING PLASTIC DEFORMATION. I. REVIEW OF WORK.
Yu.P.Romashkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3050-8 (Dec., 1960). In Russian.

A review and appraisal of published work relating the diffusion coefficient to plastic deformation. There are 18 references and a comprehensive tabular summary of available experimental results. See also two following abstracts. [English translation in: Soviet Physics–Solid State (USA)].
R.F.S.Hearmon

3982 THE THEORY OF DIFFUSION IN METALS UNDERGOING PLASTIC DEFORMATION. II. GENERAL FUNCTIONAL RELATIONS. Yu.P.Romashkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3059-64 (Dec., 1960). In Russian.

The concept of a non-equilibrium creation and disappearance of defects is used to obtain equations relating increase in the diffusion coefficient to stress, creep, creep rate, temperature and relaxation time. Particular cases of these equations are analysed, and it is shown that the change in the diffusion coefficient depends markedly on temperature. [English translation in: Soviet Physics–Solid State (USA)].
R.F.S.Hearmon

3983 THE THEORY OF DIFFUSION IN METALS UNDERGOING PLASTIC DEFORMATION. III. POSSIBLE NATURE OF THE PHENOMENON. Yu.P.Romashkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 12, 3065-76 (Dec., 1960). In Russian.

The thermodynamic correspondence between creep and diffusion, and the structural nature of the diffusion acceleration are considered. Assuming that creep and diffusion acceleration are both activation processes, the diffusion acceleration is estimated and found to agree with experiment. The part played by non-equilibrium vacancy concentration in creep and diffusion acceleration is explained. [English translation in: Soviet Physics–Solid State (USA)].
R.F.S.Hearmon

3984 THE INITIATION OF SLIP IN SILICON–IRON. J.Holden.
Acta metallurgica (Internat.), Vol. 8, No. 7, 424-30 (July, 1960).

Observations have been made on the deformation of silicon–iron crystals containing small precipitates surrounded by clusters of dislocations. Slip bands are observed to develop from the clusters, and two mechanisms are distinguished.

3985 REPEATED YIELDING OF IMPURE TIN CRYSTALS UNDER SUCCESSIVE IMPACT LOADING. K.Ishii.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1822 (Dec., 1959).

The behaviour of tin crystals has been examined under successive impact loading using a pair of pendulums. Repeated yielding was observed for specimens prepared from 99% pure tin. At higher velocities of impact the yielding was less distinct. With specimens of 99.99% pure tin slip proceeded smoothly and did not depend on the velocity of impact. It is suggested that repeated yielding is due to segregation restricting slip and so producing a stress concentration in front of the slipped region. This releases dislocations locked in the undeformed material. Ageing appears to have only a small effect. A.E.Kay

3986 THERMALLY-ACTIVATED GLIDE IN MAGNESIUM CRYSTALS FROM 4.2° to 420° K.
H.Conrad, R.Armstrong, H.Wiedersich and G.Schoeck.
Phil. Mag. (GB), Vol. 6, 177-88 (Feb., 1961).

The effect of changes in strain rate and temperature on the flow stress of Mg single crystals was determined in the range of 4.2° to 420° K. The present data, along with those obtained previously, indicate that the intersection of dislocations is the controlling mechanism. Cottrell's original model must, however, be modified to include an effect of stress on the activation volume. This effect appears to be due primarily to the fact that the force between two intersecting dislocations varies with their distance of separation rather than a change in the effective forest spacing.

ELASTIC PROPERTIES OF AN EDGE DISLOCATION WALL.
See Abstr. 3665

3987 MECHANICAL EFFECT OF X-RADIATION ON CRYSTALS. W.Gorski.
Naturwissenschaften (Germany), Vol. 47, No. 23, 537 (1960). In German.

Describes some observations on the hardening of rock salt on exposure to X-rays. Only qualitative results are given.
A.R.Stokes

EFFECT ON NEUTRON IRRADIATION ON HARDNESS OF Cu, Fe AND Fe ALLOYS.
See Abstr. 3698

3988 THE CONTRIBUTION OF PRECIPITATION TO STRAIN AGEING IN LOW CARBON STEELS.
D.V.Wilson and B.Russell.
Acta metallurgica (Internat.), Vol. 8, No. 7, 468-79 (July, 1960).

At first, strain ageing in a low carbon steel is concerned with atmosphere locking of dislocations, but mechanical tests have shown that solute segregation beyond this first stage increases strength by a form of precipitation hardening. A comparison of the change in lower yield stress ΔY and in electrical resistivity during strain ageing shows that there is a sudden decrease in the effectiveness of solute segregation, in further increasing ΔY, at the end of the first stage. Estimates based on the Cottrell–Bilby equation suggest that this occurs at dislocation atmosphere densities not greatly in excess of one atom per atom plane. Segregates formed just beyond the completion of atmosphere locking disperse rapidly on re-straining and ageing, and are probably solute clusters. Continued ageing gives more stable precipitates, probably along the dislocations, but an electron microscopical examination has shown that, at ageing temperatures of 60° C or less, these remain extremely small. The increase in ΔY during the early stages of precipitation is approximately proportional to the number of solute atoms segregating to unit length of dislocation, and is insensitive to the dislocation density L. But at higher segregate concentrations (~ 3-10 times that required for atmosphere locking) continued segregation is less effective in increasing ΔY, also ΔY tends to increase with L. The increment in strain hardening capacity due to precipitation is sensitive to the amount of prestrain, and appears to be approximately proportional to $L^{3/2}$. Assuming precipitation is on dislocations, this agrees with the relationship suggested by Fisher et al.

3989 EFFECT OF INTERLAMELLAR BISULFATE IONS UPON THE FLEXURAL STRENGTH AND DIMENSIONS OF POLYCRYSTALLINE GRAPHITE. E.A.Kmetko.
J. Chim. phys. (France), Vol. 58, No. 1, 115-19 (Jan., 1961).

Intercalation of bisulphate ions in graphite was found to increase the flexural breaking strength at low ion concentrations and also to cause anisotropic expansion. At high concentrations the breaking strength was found to decrease. The results are explicable on the assumption that the expansion at first relieves locked-in tensile stresses. At high concentrations, however, the expansion creates new stresses and leads to a decline in strength. It was considered that the effects of neutron irradiation on some mechanical properties of graphite might be explained in a similar fashion.
J.Thewlis

3990 PHYSICS OF THE STRENGTH OF CRYSTALLINE MATERIALS. R.I.Garber and I.A.Gindin.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 1, 57-110 (Jan., 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 1, 41-77 (July-Aug., 1960).

A review examining present physical ideas concerning the strength of crystalline materials, the reasons for the low strength of real materials and the main ways of increasing their strength. The effects of microscopic cracks, the origin of embryonic cracks, strength of fibre crystals, rupture involving creep, and fatigue and hardening are considered. R.F.Peart

3991 THE QUESTION OF STRENGTH ANISOTROPY OF CONSTRUCTIONAL MATERIALS. É.I.Brainin.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 8, 1006-7 (Aug., 1960). In Russian.

For abstract, see Abstr. 21140 of 1960. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 5, No. 8, 938 (Feb., 1961)].

3992 THE MECHANISM OF FRACTURE OF METALS IN CREEP. B.Ya.Pines and A.F.Sirenko.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 5, 1061-4 (Oct. 11, 1960). In Russian.

Time-to-rupture tests were carried out at various temperatures on copper specimens, either made by powder metallurgy techniques and subsequently subjected to various heat and mechanical treatments or cut from electrodeposited plates. At room temperature similar results were obtained for annealed and work-hardened specimens, but the time-to-rupture at high temperatures under a given applied stress decreased with increasing degree of lattice distortion. The results obtained provided additional support for the theory due to Zhurkov et al. [Zh. tekh. Fiz., Vol. 23, 1677 (1953)] according to which fracture in creep is associated with a diffusion growth of microcracks present in metals. This process continues until the cracks reach a critical size at which an "avalanche" growth begins leading ultimately to fracture. [English translation in: Soviet Physics—Doklady (USA)]. M.H.Sloboda

3993 THE EMBRITTLEMENT OF MOLYBDENUM BY NEUTRON IRRADIATION. A.A.Johnson.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 413-16 (April, 1960).

Comparison with previous results with EN2 steel showed that the mechanism of embrittlement is more complex in Mo. The differences and the reasons for them are briefly discussed.
H.E.Schmid

3994 THE SHEAR COMPONENT OF DUCTILE FRACTURE. K.E.Puttick.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 759-62 (July, 1960).

In the fracture of cylindrical tensile testpieces, the final separation along a shear cone is usually explained in terms of adiabatic heating of material in the shear zone. It is suggested instead that the final cone fracture is due to stress concentrations caused by necking and it is found that the cone fracture can be eliminated when the specimen is tested on a very "hard" machine, so that the final fracture occurs under decreasing load, but constant stress.
H.Mykura

3995 STRESS CONCENTRATION AT CRYSTAL SURFACES AND THE EMBRITTLEMENT OF SODIUM CHLORIDE. D.M.Marsh.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 1197-9 (Nov., 1960).

Photoelastic techniques suggested that there is a stress concentration effect at the root of a surface step almost equal to that of a Griffith crack of comparable dimensions. Two possible mechanisms of embrittlement in ionic crystals due to cleavage steps are discussed. J.E.Caffyn

3996 EFFECT OF SLIP DISTRIBUTION ON THE FRACTURE BEHAVIOUR OF MAGNESIUM OXIDE SINGLE CRYSTALS. R.J.Stokes, T.L.Johnston and C.H.Li.
Phil. Mag. (GB), Vol. 6, 9-24 (Jan., 1961).

The tensile deformation of chemically polished magnesium oxide crystals was correlated with the distribution of slip at the onset of plastic flow. If two slip bands, generated on orthogonal {110}

planes, happen to intersect so as to nucleate a crack before other slip bands develop nearby, then the crack so formed is unstable and the crystal completely brittle. If, however, there is a higher density of slip sources cracks can become stabilized by adjacent slip bands and the crystals continue to deform. Sometimes slip is confined to a single slip band which expands laterally to fill the entire gauge length, these crystals are extremely ductile. The fracture behaviour of a given crystal depends critically upon the relative orientation, number, thickness and spacing between slip bands. The density of slip may be increased artificially when dislocation sources are injected into the crystal surface by sprinkling with carborundum before loading. Such crystals are always ductile in tension. A similar treatment for crystals to be bent leads to a profound change in their fracture behaviour.

3997 RESISTANCE TO THERMAL SHOCK IN CERAMIC MATERIALS. L.F.Olmos.
Rev. Cienc. apl. (Spain), Vol. 14, No. 3, 238-44 (May-June, 1960). In Spanish.

Reviews briefly the various studies which have been made of the resistance, and the physical properties which are of importance. Particular consideration is given to materials of high coefficient of dilatation and to a series of pastes made from feldspar. 45 refs.
S.Weintroub

3998 BRITTLE FRACTURE OF METALS. V.I.Sarrak.
Uspekhi. fiz. Nauk (USSR), Vol. 67, No. 2, 339-61 (Feb., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2(67), No. 1, 150-64 (Jan.-Feb., 1959).

A review of theory and experiments up till 1957. A.E.Kay

3999 AN OBSERVATION OF CRACK FORMATION IN MgO. W.G.Johnston.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 407-8 (April, 1960).

Observations are presented which support the proposals of Stokes et al. (Abstr. 21143 of 1960) for crack formation in MgO single crystals. The etch-pit methods used were too crude to give conclusive proof of the operation of the Stroh mechanism, since the actual coalescence of the dislocations could not be observed.
R.Bullough

4000 POSSIBLE DISLOCATION GATING MECHANISMS FOR FATIGUE EXTRUSION. A.J.Kennedy.
Phil. Mag. (GB), Vol. 6, 49-53 (Jan., 1961).

Cross-slip now appears to be an important factor in the initiation of fatigue cracks, and this lends support to the Mott screw-cycling model. The reason for progressive unidirectional cycling of the required kind under alternating stress is, however, not easily understandable. Two possible gating mechanisms are here proposed to account for this effect, both of which involve interactions with Lomer—Cottrell barriers. One of these mechanisms can provide an explanation for the very rapid appearance of extrusions in a few cycles of stress, and does not require any initial internal void to exist, as does Mott's original model.

4001 STUDY OF THE INFLUENCE OF SOME FACTORS ON THE MICROHARDNESS OF SINGLE CRYSTALS OF KCl AND NaCl.
Yu.S.Boyarskaya, Yu.P.Keloglu, M.K.Bologa and S.M.Dunaeva.
Kristallografiya (USSR), Vol. 5, No. 1, 98-104 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 88-95 (July-Aug., 1960).

It is found that the indentation microhardness and scratch hardness of KCl single crystals depend on the preliminary solution of the tested surface. With variation in the solution time, the hardness at first increases and then reverts to its original value. An attempt is made to explain the results obtained from the point of view of the dislocation theory. A study was made of the influence of solution on the microhardness of NaCl single crystals, subjected to repeated colouring and bleaching.

4002 MECHANISM OF WEAR IN POLYMERS AND A SIMILARITY CRITERION. S.B.Ratner.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 2, 294-7 (Nov. 11, 1960). In Russian.

The wear of various materials (highly elastic, plastoelastic, rigid-elastic, elastoplastic, and rigid) is classified into the categories of frictional and abrasive wear, and the wear of polymers is illustrated by photographs. The results of a brief mathematical analysis are compared qualitatively with experiment. [English translation in: Soviet Physics—Doklady (USA)].
R.F.S.Hearmon

4003 THE ABRASION OF UNEQUAL SIZED FRICTIONAL SURFACES. V.D.Evdokimov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 573-6 (Nov. 21, 1960). In Russian.

The relative wear of a large and a small surface in dynamic frictional contact is discussed in relation to a model representing surface defects. Experimental results are reported for relative wear and microhardness of pairs of surfaces formed from NaCl, Cu, steel and gypsum. For all four materials, the larger surface wears at a greater rate than the smaller. [English translation in: Soviet Physics—Doklady (USA)].
R.F.S.Hearmon

4004 THE FRICTIONAL PROPERTIES OF LIGNUM VITAE. K.G.McLaren and D.Tabor.
Brit. J. appl. Phys., Vol. 12, No. 3, 118-20 (March, 1961).

A study was made of the frictional properties of lignum vitae, an extremely hard wood which finds an important application in underwater bearings. In the dry state, the friction of this material is comparable with that of P.T.F.E. and experiments show that this is due to the lubricating action of woodwaxes expressed from the wood during sliding. The rolling friction due to hysteresis losses is very small. The sliding friction can be explained satisfactorily in terms of an adhesion mechanism.

STRUCTURE OF SOLIDS

4005 THE INFLUENCE OF NEUTRON IRRADIATION ON THE PHASE CHANGES IN CHROMIUM STEELS. B.Weiss-Hollerwöger.
Nukleonik (Germany), Vol. 2, No. 6, 222-7 (Nov., 1960). In German.

The austenite—martensite transformation in chromium steel was studied before and after irradiation in a nuclear reactor at total doses up to 10^{18} neutrons/cm^2. The results agreed with those to be expected on the strain-embryo theory of Cohen [Progress in Metal Physics, 165 (1958)].
J.Thewlis

4006 THE POLYMORPHISM OF SOME CHALCOGENIDES OF ZINC AND CADMIUM.
A.S.Pashinkin, G.B.Tishchenko, I.V.Korneeva and B.N.Ryzhenko.
Kristallografiya (USSR), Vol. 5, No. 2, 261-7 (March-April, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 243-8 (Sept.-Oct., 1960).

In growing zinc selenide and telluride, and cadmium telluride crystals from the gaseous phase, polymorphous modifications of these crystals were obtained. Zinc selenide, depending on the experimental conditions, crystallizes either in a three-layer cubic packing (sphalerite), or in a mixed two- and three-layer packing with the two- and three-layer regions alternating. This modification of zinc selenide is apparently metastable. New modifications having a multilayer packing were found for zinc and cadmium tellurides: ZnTe 15R and CdTe 12H.

CRYSTALLOGRAPHY

4007 GROUP TENSOR SPACES. Yu.I.Sirotin.
Kristallografiya (USSR), Vol. 5, No. 2, 171-9 (March-April, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 157-65 (Sept.-Oct., 1960).

A new method is presented for deriving tensors of a given symmetry, namely, constructing them from certain basic tensors. Methods are given for selecting the basic tensors from which to construct the desired tensor; a specification is given for the symmetry each of those tensors must have. Detailed tables are given for the dimensions of the group tensor spaces.

4008 COMPLETE SYMMETRY OF SCALARS, VECTORS, AND TENSORS OF RANK TWO. I.S.Zheludev.
Kristallografiya (USSR), Vol. 5, No. 3, 346-53 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 328-34 (Nov.-Dec., 1960).

The concept of complementary and complete symmetry of

tensors is introduced. It is shown that there are ten groups of complete symmetry of polar tensors of rank two (among these groups there is one group of scalars and one group of axial tensors) and ten groups of complete symmetry of axial tensors of rank two (among them one pseudoscalar group and one polar vector group).

4009 MECHANICAL TWINNING IN THIN EVAPORATED GOLD FILMS.
A.Catlin, W.P.Walker and K.R.Lawless.
Acta metallurgica (Internat.), Vol. 8, No. 10, 734-5 (Oct., 1960).

Apparent mechanical twinning of thin single-crystal Au films was observed in the electron microscope at resolved shear stresses of approximately 5×10^8 dyn/cm^2 (resolved shear strain of 0.3%). Increasing the stress produced the appearance of small bands which, according to X-ray studies, were twin bands, the twinning having occurred on the (111) planes. J.Thewlis

4010 THE INFLUENCE OF INCLUSIONS ON THE TWINNING OF ZINC CRYSTALS.
V.M.Kosevich, N.G.Moroz and V.I.Bashmakov.
Kristallografiya (USSR), Vol. 5, No. 3, 426-31 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 402-6 (Nov.-Dec., 1960).

The influence of foreign inclusions, fine grains, and plastically deformed regions on twinning was studied. The basic mechanism of interaction of a twin layer with an inclusion consists in the boundary of the twin layer bending around the inclusions. Factors determining the flexibility of the boundaries of twin layers are discussed.

4011 MICROGRAPHICAL EVIDENCE OF THE POLYGONIZATION OF HIGH-PURITY COPPER.
F.Bourelier and J.Montuelle.
C.R. Acad. Sci. (France), Vol. 250, No. 26, 4355-7 (June 27, 1960). In French.

4012 ON THE TENDENCY TO POLYGONIZATION IN COPPER PURIFIED BY ZONE MELTING.
J. Le Héricy, F.Bourelier and J.Montuelle.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1779-81 (Oct. 24, 1960). In French.

Polygonization in very high purity copper was detected using the procedure of Bourelier and Montuelle (preceding abstract). The authors conclude that polygonization is easier the high the purity. D.G.Holloway

4013 EVAPORATION AND THERMAL ETCHING.
E.D.Hondros and A.J.W.Moore.
Acta metallurgica (Internat.), Vol. 8, No. 9, 647-53 (Sept., 1960).

Measurements of the loss of weight during thermal etching of silver have been compared with estimates of the mass of silver which would have to be removed to produce the etched structure (valley capacity). Up to about 5 hr etching time at 900°C the two figures correspond. After this there is little change in the valley capacity of the surface, although silver continues to be removed at a constant rate. If net evaporation is prevented by heating the silver in air in a silver container, a polished surface will not become etched and an etched surface will become smooth. Thus, it is concluded that net evaporation is necessary to produce and to maintain the thermally etched structure and that the tendency to establish a minimum of surface energy is not the driving force of the process.

4014 ETCHING AND POLISHING STUDIES ON MAGNESIUM OXIDE SINGLE CRYSTALS.
T.K.Ghosh and F.J.P.Clarke.
Brit. J. appl. Phys., Vol. 12, No. 2, 44-50 (Feb., 1961).

The action of two etchants on magnesium oxide has been studied. Etch pits, pyramids and hillocks may be produced and both etchants dissolve away the crystal surface. Activation energies for dissolution are estimated and the etching processes discussed with particular reference to dislocations and impurities.

4015 THE NATURE OF ETCH FIGURES IN Al—Cu ALLOYS.
V.G.Rakin and N.N.Buinov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 686-91 (1958). In Russian.

Four alloys in the composition range 0.25-4% Cu were investigated under an electron microscope. The etchants were aqua regia, Lacombe's reagent and Tucker's reagent. Electro-polished surfaces were also studied. The following were established: (1) the etch figures are connected with the presence of screw dislocations; (2) the form of the figures depends on the extent of alloy breakdown, on Cu content and on the alloy's tendency to ageing; (3) along the sub-boundaries there is a network-like distribution of dislocations; (4) etch figures correspond to sub-grains or to mosaic blocks. [English translation in: Phys. Metals and Metallography (GB), Vol. 6 No. 4, 105-10 (1958)].

4016 USE OF THE ETCH METHOD FOR REVEALING DISLOCATIONS IN ROLLED PLATES OF SILVER CHLORIDE. V.M.Stepanova, V.V.Pokrovskii and V.R.Regel'.
Kristallografiya (USSR), Vol. 5, No. 1, 108-14 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 100-5 (July-Aug., 1960).

The results are described of etching annealed and unannealed plates of AgCl produced by rolling from single crystals. A connection is found between the etch pits and the emergence of edge and screw dislocations. It is shown that the form of the etch pits depends upon the crystallographic orientation of the surface grains in rolled and annealed plates of AgCl. The possibility is examined of slip traces penetrating the grain boundaries according to the disorientation.

4017 APPLICATION OF IONIC ETCHING FOR REVEALING THE DISLOCATIONS IN METAL CRYSTALS.
V.E.Yurasova, É.A.Pavlovskaya, N.A.Tyapunina and A.A.Predvoditelev.
Kristallografiya (USSR), Vol. 5, No. 3, 437-40 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 413-17 (Nov.-Dec., 1960).

A method is described for revealing the dislocations in cadmium crystals by ionic etching. The results obtained in ionic etching and electropolishing are shown to be identical. A comparison is drawn between the character of etch figures and their arrangement and the concepts of the dislocation theory. The observed agreement with theory indicates a connection between these figures and dislocations.

4018 THE ETCHING OF SUB-STRUCTURES IN BERYLLIUM.
J.Sawkill and J.E.Meredith.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 1195-6 (Nov., 1960).

Aqueous solutions containing a few hundred parts per million of copper will make visible the grain boundaries and sub-structures in Be through copper deposition. H.Mykura

SELECTIVE ETCHING OF DISLOCATIONS IN CALCITE. See Abstr. 3668

4019 DIRECTIONS OF PREFERENTIAL GROWTH OF METAL CRYSTALS FROM MELT. V.O.Esin.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 233-9 (Aug., 1960). In Russian.

Discusses preferential crystal growth in very pure metals on the basis of the anisotropy of growth of various crystal faces. Calculations show that an increase of the purity of a metal may alter the direction of preferential growth, in agreement with the experimental results obtained for lead by other workers. A.Tybulewicz

4020 SPIRAL GROWTH LAYERS ON SODIUM NIOBATE CRYSTALS. N.V.Gliki and V.A.Timofeeva.
Kristallografiya (USSR), Vol. 5, No. 1, 105-7 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 96-9 (July-Aug., 1960).

The features of the spiral microrelief of the faces of these crystals grown from a molten solution are examined and a description is given of the internal structure of crystals having spirally stepped depressions on the faces.

4021 GROWTH KINETICS OF CRYSTALS OF TIN.
É.Anastasiadis.
Kristallografiya (USSR), Vol. 5, No. 2, 303-11 (March-April, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 281-7 (Sept.-Oct., 1960).

Cinemicrography was used to study tin crystals growing from solution. The growth is periodic in two stages (extension and broadening); adjacent crystals grow into one another; dendrites become tabular dipyramids.

4022 CONDENSATION COEFFICIENTS IN THE GROWTH OF CADMIUM AND ZINC FROM THE VAPOR.
R.A.Rapp, J.P.Hirth and G.M.Pound.
J. chem. Phys. (USA), Vol. 34, No. 1, 184-8 (Jan., 1961).

Condensation coefficients of essentially unity are determined for the growth of zinc and cadmium from the vapour phase at high supersaturations in ultra-high vacua. These data indicate that no impingent atoms are reflected, and that all adsorbed atoms are incorporated into the growing crystal by Volmer's disk nucleation and growth mechanism. The adsorption of gaseous impurities at a residual gas pressure of 10^{-4} mm Hg did not affect the condensation coefficient for condensation at high fluxes.

4023 THE THEORY OF "SHOCK WAVE" STEPS ON A CRYSTAL SURFACE. A.A.Chernov.
Kristallografiya (USSR), Vol. 5, No. 3, 446-51 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 423-8 (Nov.-Dec., 1960).

The "shock waves" of the density steps which arise during crystallization and decrystallization on the surface of a crystal are examined. It is shown that the density jump disappears in the course of time. The rate of this disappearance is established. A qualitative consideration of the part played by the surface energy of the crystal leads to the conclusion that density waves can be transformed into stable macroscopic steps which are conditioned by the anisotropy of the surface energy. For large initial density disturbances, this transformation must occur.

4024 CLOUDING ("AGING") OF PRESSINGS OF IONIC CRYSTAL POWDERS. Ya.E.Geguzin, V.I.Startsev, M.G.Buravleva, R.A.Madikyan, T.P.Narbut and A.A.Shpunt.
Kristallografiya (USSR), Vol. 5, No. 2, 295-302 (March-April, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 274-80 (Sept.-Oct., 1960).

Data are presented on the kinetics of the reduction in transparency of pressings of powders of ionic crystals. Optical and X-ray measurements provide evidence in support of the concept of a diffusion mechanism for the formation of scattering centres in the pressings.

4025 GROWING OF SINGLE CRYSTALS OF NaI(Tl) WITH DOUBLE TEMPERATURE CONTROL.
B.A.Belikovich and A.B.Lyskovich.
Kristallografiya (USSR), Vol. 5, No. 1, 126-8 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 116-18 (July-Aug., 1960).

Single crystals, 70 × 70 mm and possessing good spectrometric properties, were obtained using two independent heaters in the furnace to control the growth rate at different points of the growing crystal.

4026 GROWING OF DISLOCATION-FREE GERMANIUM SINGLE CRYSTALS. E.Yu.Kokorish and N.N.Sheftal'.
Kristallografiya (USSR), Vol. 5, No. 1, 156-7 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 150-2 (July-Aug., 1960).

Crystals were pulled from the melt into a controlled temperature gradient. Large dislocation-free single crystals were produced from special seeds. D.G.Holloway

4027 CRYSTAL GROWING BY THE TEMPERATURE DIFFERENCE METHOD WITH FREE CONVECTION CONDITIONS OF THE SOLUTION. T.G.Petrov and E.B.Treibus.
Kristallografiya (USSR), Vol. 5, No. 3, 452-8 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 429-34 (Nov.-Dec., 1960).

The physical principles of the method applied to crystal growing from solutions at temperatures up to 100°C and at atmospheric pressure are examined. More exact ways of selecting the optimum conditions are specified. Experimental results are given of the application of the method to the growing of crystals of a number of substances from aqueous solution.

4028 THE PREPARATION OF SINGLE CRYSTALS OF SILICON BY THE CZOCHRALSKY PROCESS.
G.Greger.
Z. angew. Phys. (Germany), Vol. 13, No. 1, 47-51 (Jan., 1961). In German.

The homogeneity of the resistivity and the dislocation density were examined for crystals grown in H_2, A and in vacuum. The best samples were produced in vacuum using resistance heating. D.G.Holloway

4029 ZONE REFINING OF THE SILVER HALIDES.
F.Moser, D.C.Burnham and H.H.Tippins.
J. appl. Phys. (USA), Vol. 32, No. 1, 48-54 (Jan., 1961).

The techniques of zone melting have been applied to AgCl and AgBr in an attempt to obtain large crystals of extremely high purity. By measuring distributions in ingots with deliberate impurity additions, both optimum conditions for zoning and distribution coefficients for several impurities were determined. For AgCl, zone melting in a chlorine atmosphere led to near-ultimate distributions for Cu, Pb, Ni, and Fe after passage of 70 zones at a rate of 3 in./hr. The distribution coefficients determined were as follows: Cu, 0.4; Pb, 0.4; Ni, 1.4; and Fe, 0.7. Zone melting in vacuum resulted in similar distributions for Cu, Pb, and Ni, but Fe separated with an effective distribution coefficient slightly greater than one. Under these conditions, Mn and Cd separated in a direction opposite to that of zone travel, and Sn, Al, and Sr separated in the direction of zone travel. Zone refining of nominally pure AgCl resulted in crystals which probably contain less than one part in 10^9 of Cu and Ni, less than one part in 10^8 of Pb, and less than five parts in 10^8 of Fe. Limited data on AgBr indicate that in this case, too, useful purification can be obtained. The dark electrical conductivity of the zoned crystals was found to be intrinsic above 315°K for AgCl and 300°K for AgBr.

4030 IRON WHISKER SURFACE REARRANGEMENTS RESULTING FROM THE HYDROGEN REDUCTION OF OXIDES AND FROM THERMAL ETCHING.
J.V.Laukonis and R.V.Coleman.
J. appl. Phys. (USA), Vol. 32, No. 2, 242-7 (Feb., 1961).

The hydrogen reduction of high-temperature oxidation products grown on iron whiskers produces iron surfaces whose topography depends on the orientation of the surface that was oxidized. The different topographies for {100} and {110} surfaces are shown, and the dependence is further illustrated on the polycrystalline iron surfaces which result from the heating of a single-crystal α-iron whisker through its transformation temperature of 910°C. Rearranged surface covered with parallel striations and unusual dendritic surfaces structures are shown and discussed. Both the striations and dendrites are the result of thermal etching of a "polycrystalline" iron whisker at temperatures between 800° and 1200°C.

4031 SOME ASPECTS OF THE CHEMICAL CRYSTALLOGRAPHY OF PIEZOELECTRICS. I.S.Rez.
Kristallografiya (USSR), Vol. 5, No. 1, 63-70 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 54-60 (July-Aug., 1960).

The rules of chemical crystallography relating to piezoelectric substances are surveyed to provide a means of detecting new piezoelectrics; 18 distinct groups of substances are indicated as justifying detailed examination.

CRYSTAL LATTICE STRUCTURES

4032 METALLIC STRUCTURES WITH HIGH COORDINATION NUMBERS. P.I.Kripyakevich.
Kristallografiya (USSR), Vol. 5, No. 1, 79-83 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 1, 69-76 (July-Aug., 1960).

One can isolate from the structural types of metal and intermetallic compound a class of structures in which some of the atoms have a coordination number 12, and the others have one >12. The coordination characteristics of these structures are given; coordination polyhedra with the number of vertices ≥12 are described, and the relationships between the separate structure types of this class analysed.

4033 PHASE TRANSITIONS WITHOUT CHANGE IN THE NUMBER OF ATOMS IN THE UNIT CELL OF THE CRYSTAL. V.L.Indenbom.
Kristallografiya (USSR), Vol. 5, No. 1, 115-25 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 106-15 (July-Aug., 1960).

Using representations of point groups, a general method is developed for the study of the relationship between the structure and the properties of a crystal, including structural transformations preserving the number of atoms in the unit cell. Representations

are tabulated that correspond to all possible ferroelectric and ferromagnetic phase transitions, transitions of the second kind, and those that form twins of different types.

4034 SYMMETRIES OF THE WEIGHTED ELECTRON-DENSITY PROJECTIONS FOR CRYSTALS FALLING IN THE GROUPS OF LOWEST SYMMETRY. I.M.Rumanova.
Kristallografiya (USSR), Vol. 5, No. 2, 180-93 (March-April, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 166-79 (Sept.-Oct., 1960).

The symmetries (one- and two-colour) of the weighted densities are considered and tabulated for all 74 space groups falling in the triclinic, monoclinic, and orthorhombic systems.

4035 ANTISYMMETRY OF TRANSFORMATION OF FOURIER FORMS. B.K.Vainshtein.
Kristallografiya (USSR), Vol. 5, No. 3, 341-5 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 323-7 (Nov.-Dec., 1960).

A simple correspondence determined by the Fourier transformation between symmetry and antisymmetry point groups, and the relation of the latter to the Laue classes, is established.

4036 APPLICATION OF A 400 keV ELECTRON-DIFFRACTION APPARATUS TO THE STUDY OF SINGLE CRYSTALS. N.M.Popov and B.B.Zviagin.
Kristallografiya, Vol. 3, No. 6, 706-8 (Nov.-Dec., 1958). In Russian.

The advantages of Popov's apparatus are described, and photographs of single crystals of clay minerals are reproduced. [English translation in: Soviet Physics—Crystallography (New York), Vol. 3, No. 6, 712-15 (Jan., 1960)]. A.R.Stokes

4037 DETERMINATION OF CRYSTALLITE SIZE DISTRIBUTIONS FROM X-RAY LINE BROADENING. A.Bienenstock.
J. appl. Phys. (USA), Vol. 32, No. 2, 187-9 (Feb., 1961).

The broadening of an $00l$ powder diffraction line caused by a distribution of sizes of crystallites is discussed. A function of the intensity, $P(h_3)\sin^2(\pi h_3)$, is derived. Its cosine transform gives the size distribution directly. The first term of a series expansion of this distribution function corresponds to the expression previously obtained by Warren and Averbach (Abstr. 6755 of 1950). This function gives less weight to the extremes of the diffraction line shape.

4038 [DIFFUSE] SCATTERING OF X-RAYS BY HIGHLY DISTORTED HOMOGENEOUS SOLID SOLUTIONS. M.A.Krivoglaz.
Kristallografiya (USSR), Vol. 5, No. 1, 24-31 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 18-23 (July-Aug., 1960).

The power series for the intensity in terms of the displacements is taken further than in Abstr. 7538 of 1959. It is found that these higher terms cause an asymmetry in the intensity distribution near the nodes of the reciprocal lattice and a deviation from lemniscate form in the isodiffuse curves. These effects are more marked in the higher reflection orders. Ideal and nonideal solutions are considered. The higher terms become especially important near the critical point on the decomposition curve and if the defects responsible for the scattering combine into groups.

4039 INFLUENCE OF THE SIZE DISTRIBUTION OF MOSAIC BLOCKS ON X-RAY SCATTERING. A.G.Khachaturyan.
Kristallografiya (USSR), Vol. 5, No. 3, 354-8 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 335-8 (Nov.-Dec., 1960).

The size-distribution function of blocks is calculated on the basis of general statistical considerations. The form of the Fourier coefficient of the interference function is determined, and a comparison with experimental data in the literature is carried out. A new method for determining the average sizes of the blocks is proposed.

4040 THE α-Mn AND β-Mn STRUCTURES. P.I.Kripyakevich.
Kristallografiya (USSR), Vol. 5, No. 2, 273-81 (March-April, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 253-61 (Sept.-Oct., 1960).

A description of these structures is given, based on the coordination characteristics of the atoms; the structures of these modifications are compared with each other and with other types of structure.

4041 DEPENDENCE ON TEMPERATURE OF THE INTERLAYER SPACING IN CARBONS OF DIFFERENT GRAPHITIC PERFECTION. E.G.Steward, B.P.Cook and E.A.Kellett.
Nature (GB), Vol. 187, 1015-16 (Sept. 17, 1960).

Earlier work on thermal expansion (see Abstr. 8291 of 1960) was extended to lower and higher temperatures (−196°C to 2600°C). It was concluded that the high-temperature behaviour depends mainly on interlayer spacing, whereas at low temperatures imperfections and stacking-disorder effects play the predominant part. Neutron irradiation had the same effect on the low-temperature behaviour as stacking disorder. J.Thewlis

4042 MEASUREMENT OF THE DEBYE–WALLER TEMPERATURE FACTOR FOR SILVER AND α-IRON. C.W.Haworth.
Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1229-34 (Dec., 1960).

Measurements were made of the variations with temperature of intensities of X-ray diffraction lines from silver and iron. For silver the measurements were in the range 286-1100°K, and the Debye–Waller temperature factor corresponded to a characteristic temperature of 197°K at 286°K. For iron the measurements covered the range 286-1190°K, and corresponded to $\Theta = 389$°K, although there was a large scatter in the results due to crystal changes brought about by annealing. The intensity measurements showed no discontinuity at the Curie temperature, nor was there any anomaly in the spacing of the (110) planes.

4043 CRYSTAL STRUCTURE OF SOLID DEUTEROHYDROGEN. R.F.Bulatova, V.S.Kogan and B.G.Lazarev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6(12), 1853, (Dec., 1960). In Russian.

The preparation of HD is briefly described. Low-temperature X-ray examination gave the following data: space group C_4^5, $a = 3.39$ A, $c = 5.86$ A, calculated density 0.146 g/cm^3. The structure is compared with those of solid H_2, D_2, and T_2. [English translation in: Soviet Physics—JETP (USA)]. R.F.S.Hearmon

4044 AN X-RAY STUDY OF Rb_3Bi AND Rb_3Sb. N.N.Zhuravlev, V.A.Smirnov and T.A.Mingazin.
Kristallografiya (USSR), Vol. 5, No. 1, 134-7 (Jan.-Feb., 1960). In Russian.

Powder-diffraction lines are listed which indicate that Rb_3Bi is hexagonal with $a = 6.42$ A, $c = 11.46$ A, and that Rb_3Sb is hexagonal with $a = 6.29$ A, $c = 11.17$ A. The structure is of Na_3As type. The smallest Bi–Bi distance increases, while the Bi–Rb and Rb–Rb distances decrease, on going from $RbBi_2$ (superconductor) to Rb_3Bi (semiconductor). [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 1, 124-7 (July-Aug., 1960)]. A.R.Stokes

4045 SOME PECULIARITIES OF THE STRUCTURE OF ZINC SELENIDE CRYSTALS. E.Krucheanu and Yu.D.Chistyakov.
Kristallografiya (USSR), Vol. 5, No. 3, 364-8 (May-June, 1960). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 3, 344-8 (Nov.-Dec., 1960).

Zinc selenide was obtained by synthesizing from the elements in evacuated quartz ampoules at 1380°C. ZnSe single crystals of a high degree of purity were grown from the gaseous phase in a hydrogen current. An X-ray diffraction study of the single crystals so obtained has shown that they have the hexagonal wurtzite-type structure. Growth defects were discovered, which lead to the local emergence of cubic sphalerite-type structures.

4046 ANOMALOUS NEUTRON DIFFRACTION IN α CADMIUM SULFIDE. S.W.Peterson and H.G.Smith.
Phys. Rev. Letters (USA), Vol. 6, No. 1, 7-9 (Jan. 1, 1961).

Measurements showed strong departures from Friedel's law due to absorption of neutrons by the Cd^{113} nucleus. A.R.Stokes

4047 TITANIUM DIOXIDE (BROOKITE), TiO_2. S.R.Yoganarasimhan and C.N.R.Rao.
Analyt. Chem. (USA), Vol. 33, No. 1, 155 (Jan., 1961).

Samples (free from anatase and rutile) from Magnet Cove, Ark., U.S.A. and from Canton Uri, Switzerland, were examined with X-ray Debye–Scherrer cameras and by a G.M. diffractometer. The spacings and relative intensities of 22 powder lines are listed and indexed on the basis of an orthorhombic cell with $a = 9.25$, $b = 5.46$, $c = 5.16$ A; density (calc.) = 4.07 g/cm^3; space group V_h^{15}. [See Weyl, Zeitschrift für Kristallographie, Vol. 111, 401 (1959)]. J.Iball

4048 ON THE STRUCTURE OF GREEN RUST OF IRON.
H.Yoshioka.
J. Phys. Soc. Japan, Vol. 14, No. 7, 974-5 (July, 1959).
Rings in the electron diffraction pattern of thin plate-like crystals of green rust are indexed. The results are consistent with a monoclinic unit cell. R.Reed

4049 THE ATOMIC STRUCTURE OF $RuSb_2$ AND $OsSb_2$.
R.N.Kuz'min, N.N.Shuravlev and S.A.Losievskaya.
Kristallografiya (USSR), Vol. 5, No. 2, 218-23 (March-April, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 202-6 (Sept.-Oct., 1960).
A series of antimony alloys with ruthenium and osmium were analysed by X-ray diffraction and under the microscope. The existence of the compounds RuSb, $RuSb_2$, and $OsSb_2$ was established. The compounds $RuSb_2$ and $OsSb_2$ are orthorhombic and have a marcasite-type structure.

4050 A CONTRIBUTION TO THE STUDY OF THE STRUCTURE OF LEAD SULPHUR ARSENIDES IN THE BINN STRATA. CRYSTALLINE STRUCTURE OF RATHITE III.
M.T. Le Bihan and J.Petiau.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2196-8 (Nov. 14, 1960). In French.
X-ray diffraction measurements on single crystals show that the unit cell of two molecules is monoclinic with a = 24.52, b = 7.91, c = 8.43 A, $\beta = 90.0^0$; d(obs) = 5.38 g/cm^3, d(calc) = 5.35 g/cm^3; space group $P2_1$. The Pb atoms were located from Patterson projections. Fourier projections with h0l reflections gave parameters for the arsenic atoms and these were refined by (Fo–Fc) Fourier projections and subsequent (Fo–Fc) Fourier projections gave the positions of the sulphur atoms. The structure is consistent with the formula $Pb_6As_{10}S_{20}$. No Pb–As bonds exist in the structure and all the Pb atoms do not have the same distribution of sulphur atoms around them. The individual atomic coordinates are listed together with the distances of closest approach. J.Iball

4051 THE RELATIONSHIP BETWEEN THE EQUILIBRIUM VALUE OF THE LATTICE CONSTANT OF A MIXED SPINEL AND COMPOSITION. A.N.Men'.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 5, 781-5 (1958). In Russian.
Using a special model of the spinel lattice, proposed by Orlov and Men' (1955), the constants s_k, characterizing the interaction between the electron gas and the K ion core, are evaluated. Knowing s_k, it is possible to explain the character of the relationship observed experimentally between the equilibrium value of the lattice constant of a mixed spinel and its composition. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 5, 11-15 (1958)].

4052 STUDY OF THE WURTZITE-TYPE COMPOUNDS. V. STRUCTURE OF ALUMINUM OXYCARBIDE, Al_2CO; A SHORT-RANGE WURTZITE-TYPE SUPERSTRUCTURE.
E.L.Amma and G.A.Jeffrey.
J. chem. Phys. (USA), Vol. 34, No. 1, 252-9 (Jan., 1961).
For Pt IV, see Abstr. 4397 of 1960. Al_2CO has a long-range disordered structure based on the wurtzite lattice and a short-range $\sqrt{3}a$, 2c superstructure. The long-range atomic parameters were determined from the single crystal sharp diffraction data with Mo K radiation. The diffuse spectra, although very apparent on the single-crystal X-ray photographs, were inadequate to completely define the short-range structure; however, the general features of this structure could be inferred and some analogies made to known structures which are wholly or in part wurtzite-lattice superstructures.

4053 AN X-RAY STUDY OF THE $BaNb_2O_6$–$CaNb_2O_6$ AND $BaNb_2O_6$–$SrNb_2O_6$ SYSTEMS. I.G.Ismailzade.
Kristallografiya (USSR), Vol. 5, No. 2, 268-72 (March-April, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 249-52 (Sept.-Oct., 1960).
At certain concentrations $CaNb_2O_6$ and $SrNb_2O_6$ form $BaNb_2O_6$–$CaNb_2O_6$ and $BaNb_2O_6$–$SrNb_2O_6$, solid solutions that have the structure of orthorhombic $PbNb_2O_6$. The lattice parameters were measured as functions of temperature; there is a ferroelectric phase transition Cm2m (orthorhombic)$_{T_k}$ P4/mbm (tetragonal).

4054 CADMIUM–VANADIUM SPINEL.
B.Reuter and G.Marx.
Naturwissenschaften (Germany), Vol. 47, No. 23, 539 (1960). In German.
An equimolecular mixture of CdO and V_2O_3 when heated in an evacuated quartz vessel at a temperature of 900-1000^{0}C produced a vanadium spinel (CdV_2O_4) which has a structure similar to the corresponding chromium, iron and gallium spinels. The lattice parameter is 8.68 ± 0.01 A which corresponds to a density of 5.7 g/cm^3 (the observed value is 5.5 g/cm^3). J.Iball

4055 STRUCTURE OF THE WATER MOLECULE IN SOLID HYDRATED COMPOUNDS.
J.W.McGrath and A.A.Silvidi.
J. chem. Phys.(USA), Vol. 34, No. 1, 322-5 (Jan., 1961).
The proton–proton separations in hydrated water in 10 compounds were measured by the Pake method using proton magnetic resonance. The mean value is 1.595 ± 0.003 A with a range in values from 1.56 to 1.61 A. However, consideration of experimental error in individual values of the p–p separation indicates that this range does not prove that this separation varies between compounds. Thus it appears that intermolecular forces on the protons in the water molecule are not appreciable compared to intramolecular forces. The orientations of the water moleculès were determined for eleven compounds. In every instance the orientation appears to be determined by formation of hydrogen bonds between the water oxygen and the nearest pair of electronegative atoms.

4056 THE STRUCTURES OF MILLON'S SALT AND BECTON'S SALT. M.Bukovska and M.A.Porai-Koshits.
Kristallografiya (USSR), Vol. 5, No. 1, 137-40 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 1, 127-9 (July-Aug., 1960).
Single crystals of $Cu(NH_3)_4PtCl_4$ were made by the diffusion method from solutions of H_2PtCl_3 and CuCl in ammonia. They were tetragonal with a = 0.96 ± 0.02 c = 6.4 ± 0.02 A. Density is 3.00 g/cm^3 by flotation and by calculation. No piezoelectric activity was observed. The space group is probably P4/mnc. The structure was determined from Patterson projections. The intensities were measured by visual methods from Weissenberg photographs taken with Cu Kα radiation. A Fourier section (xy0) gave the coordinates of the atoms. There are two Pt atoms in the 2(a) positions and two Cu atoms at 2(b). The four Cl and NH_3 are in general 8-fold positions with Cl at x = 0.254, y = 0.056, z = 0 and NH_3 at x = 0.217, y = –0.059, z = 0.500 (fractional coordinates). Temperature factors were B = 3.36A^2 (for hk0) and 3.0A^2 (for hkl); $R(= \Sigma \, ||Fo| - |Fc|| \, / \Sigma \, |Fo|) = 0.16$ for hk0 and 0.18 for hkl. The structure is a layer one, each layer built from $[Cu(NH_3)_4]^{2+}$ and $[PtCl_4]^{2-}$ squares. Powder patterns indicate that $Cu(NH_3)_4PtCl_4$ (violet powder) and $Pt(NH_3)_4CuCl_4$ (green powder) have the same structure. J.Iball

4057 DERIVATION OF THE STRUCTURE OF LOVOZERITE FROM SECTIONS OF THE THREE-DIMENSIONAL PATTERSON FUNCTION. V.V.Ilyukhin and N.V.Belov.
Kristallografiya (USSR), Vol. 5, No. 2, 200-14 (March-April, 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 2, 186-98 (Sept.-Oct., 1960).
The structure of lovozerite (most probable composition: $Na_2ZrSi_6O_{15}.3H_2O.0.5\,NaOH$) has been deduced from sections of the electron-density pattern. The silicon–oxygen radical is shown to be a $[Si_6(O,OH)_{18}]$ ring; the silicon–oxygen tetrahedron contains five or six OH groups.

4058 STRANSKIITE, A NEW MINERAL.
H.Strunz.
Naturwissenschaften (Germany), Vol. 47, No. 16, 376 (1960). In German.
Unit cell is triclinic: a = 5.07, b = 6.77, c = 5.28 A; $\alpha = 111^0$, $\beta = 113.5^0$, $\gamma = 86^0$. Unit cell contains $Zn_2Cu(AsO_4)_2$, with small amounts of Fe, Mg, Ca, Si also present. Optically biaxial, with $n\alpha = 1.795$, $n\beta = 1.842$, $n\gamma = 1.874$. A.R.Stokes

4059 POSITIONS OF THE HYDROGEN ATOMS IN THE STRUCTURE OF GUANIDINIUM ALUMINUM SULFATE HEXAHYDRATE. K.S.Aleksandrov, A.G.Lundin and G.M.Mikhailov.
Kristallografiya (USSR), Vol. 5, No. 1, 84-8 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 1, 77-80 (July-Aug., 1960).
Examined by means of nuclear magnetic resonance.

ALLOYS . METALLURGY

4060 A THEORY OF DILUTE SOLID SOLUTIONS. K.P.Gurov and I.B.Borovskii.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 4, 513-19 (1960)

A theory postulating formation of atomic aggregates around an impurity is shown to explain the following properties of α-iron–tungsten solid solutions: (1) a maximum in the concentration dependence of Young's modulus at 0.06 at.% W; (2) a maximum in the temperature dependence of the internal-friction coefficient; (3) a minimum in the concentration dependence of the electrical resistivity; (4) a minimum in the concentration dependence of the effective number of electrons. A.Tybulewicz

4061 ON THE THEORY OF SOLID SOLUTIONS IN COPPER, SILVER AND GOLD. W.Hume-Rothery and D.J.Roaf.
Phil. Mag. (GB), Vol. 6, 55-9 (Jan., 1961).

It is proposed that the change in crystal structure on alloying the noble metals with elements of the B sub-groups (e.g. copper–zinc) is due to the Fermi surface touching the cube faces of the Brillouin zone of the face-centred cubic structure rather than the octahedral faces which are already touched in the pure metals. A reasonable band structure for copper is consistent with this suggestion.

4062 THE ω-PHASE IN ZIRCONIUM BASE ALLOYS. B.A.Hatt and J.A.Roberts.
Acta metallurgica (Internat.), Vol. 8, No. 8, 575-84 (Aug., 1960).

The metastable ω-phase in zirconium base alloys has been found to be truly hexagonal with $c/a = 0.622 \pm 0.002$. The orientation relationships with respect to the parent β-phase (b.c.c.) are $\langle 0001\rangle\omega \parallel \langle 111\rangle\beta$, $\langle 2\bar{1}\bar{1}0\rangle\omega \parallel \langle \bar{1}01\rangle\beta$. The interpretation of X-ray data from high solute content alloys quenched from the β-phase indicates that the ω formed during quenching is heavily faulted. The ω structure in this state is designated diffuse ω. A model for the $\beta \rightarrow \omega$ transformation which satisfactorily accounts for the observed diffraction effects is developed. This is based on the gliding of $\{112\}\beta$ planes in $\langle 111\rangle\beta$ directions in a distinct sequence. The magnitude of the glide component is realistically altered to account for intensity differences in the diffractions from diffuse ω and bulk ω.

4063 HEATS OF FORMATION OF SOLID Au–Cu ALLOYS. R.L.Orr.
Acta metallurgica (Internat.), Vol. 8, No. 7, 489-93 (July, 1960).

Heats of formation were measured by liquid tin solution calorimetry for a complete series of Au–Cu alloys in equilibrium states at 720°K and for the same alloys at 320°K after rapid quenching from 873°K. The asymmetry in the heat of formation curve at 720°K is in accord with observations on the variation of short range order with composition. The considerably more exothermic heats of formation found for the quenched alloys are ascribed to an increase in the degree of short range order during quenching, which is consistent with the results of both X-ray and kinetic studies. Heats of formation of fully ordered AuCu and $AuCu_3$ alloys were also measured from which their configurational energies with respect to the "disordered" alloys at 720°K were obtained.

4064 MARTENSITIC TRANSFORMATIONS IN THE TITANIUM–ZIRCONIUM SYSTEM.
V.N.Gridnev, V.I.Trefilov and V.N.Minakov.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 6, 1334-6 (Oct. 21, 1960).
In Russian.

The martensitic transformation in Ti–Zr alloys was investigated by thermal, dilatometric, X-ray and electrical methods, and a temperature–concentration diagram of the transformation is given.
[English translation in: Soviet Physics ~ Doklady (USA)].
R.F.S.Hearmon

4065 POLYMORPHISM IN In_2Te_3. A.I.Zaslavskii and V.M.Sergeeva.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2872-80 (Nov., 1960).
In Russian.

The structural transformation $\alpha\text{-}In_2Te_3 \rightleftharpoons \beta\text{-}In_2Te_3$ was investigated by X-ray, thermal, and pycnometric methods. The exothermic transition $\beta\text{-}In_2Te_3 \rightarrow \alpha\text{-}In_2Te_3$ is a phase transformation of the first order, accompanied by an increase in density from 5.73 to 5.79 g/cm³, and occurs between 620° and 520°C. The high temperature form $\beta\text{-}In_2Te_3$ has the ZnS type structure; the low temperature form $\alpha\text{-}In_2Te_3$ is cubic with space group $F\bar{4}3m$ and $a = 18.50$ A. The structures are described in detail and previous work is analysed critically in relation to the present results.
[English translation in: Soviet Physics – Solid State (USA)].
R.F.S.Hearmon

4066 THE SHORT-RANGE ORDER AND THE CHARACTERISTIC X-RAY DIFFRACTION TEMPERATURE IN Ni_3Pt. V.I.Iveronova and A.A.Katsnel'son.
Kristallografiya (USSR), Vol. 5, No. 1, 71-8 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Physics–Crystallography (USA), Vol. 5, No. 1, 61-8 (July-Aug., 1960).

The temperature and time dependence of the parameters of the short-range order in the two first coordination spheres in the alloy were studied. It is shown that the parameter of short-range of the first coordination sphere decreases slowly, but that the second increases with temperature. The total number of atoms of the kind, under study, within the limits of two first coordination spheres, rapidly approaches a value corresponding to the average concentration of the alloy as the temperature rises. It is also shown that, the characteristic temperature determined by X-ray diffraction varies parallel to the change in the quantity

$$\Delta n_1^{PtNi} + \Delta n_2^{PtNi},$$

which is a measure of the concentration inhomogeneity in the volume of the two spheres.

4067 A NEW COMPOUND IN Au–Pb ALLOY SYSTEM. Y.Fujiki.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 197-204 (Sept., 1959).

A new phase as observed by the electron diffraction method in the thin films of Au–Pb alloy was confirmed by both the metallographic and X-ray diffraction methods with bulk specimens. This new phase was an intermetallic compound whose composition was $AuPb_3$, and was formed peritectically like the compounds Au_2Pb and $AuPb_2$. The unit cell of $AuPb_3$ is tetragonal with lattice constants $a = 11.958$ A and $c = 5.878$ A. The measured density is 12.8 g cm^{-3}, which agrees well with the calculated one on the basis of 8 molecules per unit cell (12.93 g cm^{-3}). The peritectic point of this phase is very close to the eutectic temperature (215° C).

4068 LOW TEMPERATURE CALORIMETRIC MEASUREMENTS ON ISOTHERMAL AGING OF Al–Ag. W.DeSorbo.
Acta metallurgica (Internat), Vol. 8, No. 8, 539-41 (Aug., 1960).

On quenching aluminium containing 1.3 at.% silver, energy is released upon isothermal holds at low temperatures (~245°K). The amount of energy evolved, over a measured period of time (32-140 min) after the initiation of the reaction (clustering of silver atoms) amounts to 6-7 cal/g atom of alloy for "slow" quenches and about 2-2.5 cal/g atom of alloy for "fast" quenches. These results are consistent with the resistometric studies of Turnbull et al. who pointed out the existence of two states in quenched Al–Ag alloys.

4069 ON THE DIRECT OBSERVATION, WITH THE HELP OF THE ELECTRON MICROSCOPE, OF PHENOMENA ACCOMPANYING THE RETURN TO EQUILIBRIUM OF AN Al–1.2% Si SOLID SOLUTION, DURING CONSECUTIVE TEMPERING TREATMENTS. A.Saulnier.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2160-2 (Nov. 14, 1960).
In French.

The experiments were carried out within the electron microscope, a small furnace being installed on the specimen carrier. It was found that the return to equilibrium of a supersaturated solution occurs in two stages. The first is the precipitation of vacancies, with the formation and resorption of dislocation loops. The second is the nucleation and growth of Si particles. The Si does not precipitate at the dislocation loops: nucleation is produced when the vacancies are supersaturated in the lattice. J.Thewlis

4070 CLUSTERING IN AN ALPHA IRON–MOLYBDENUM SOLID SOLUTION. E.Hornbogen.
J. appl. Phys. (USA), Vol. 32, No. 2, 135-9 (Feb., 1961).

Clustering in these alloys begins with the formation and growth of dislocation rings from supersaturated vacancies. The rings form on {100} planes and reach a maximum diameter of ~800 A.

Segregation of molybdenum to these rings starts just after their formation. Molydbenum-rich zones grow inside the rings until a disk is formed. After very long periods of aging, particles of the b.c.c.η solid solution form from the clusters at aging temperatures below 500°C.

4071 PURIFICATION OF METALS BY METHODS INVOLVING PHASE TRANSFORMATIONS.
S.Okoniewski.
Przeglad Elektron. (Poland), Vol. 1, No. 1, 39-42 (1960). In Polish.

Describes purification procedures based on multiple distillation and multiple sublimation. The purities obtainable were of the order of those currently obtainable in semiconductor technology.

A.Tybulewicz

A NOTE ON THE SELECTION RULES FOR OPTICAL TRANSITIONS IN ALLOYS. See Abstr. 3626

OTHER SOLID FORMS

4072 CONCERNING DISLOCATIONS IN GLASS.
W.B.Hillig and R.J.Charles.
J. appl. phys. (USA), Vol. 32, No. 1, 123-4 (Jan., 1961).

The concept of a dislocation is discussed and it is suggested that Levengood and Vong (Abstr. 13541 of 1960) are not justified, without further evidence, in applying the term to explain patterns obtained on the fracture surfaces of certain glasses; an alternative explanation of these patterns is given. D.M.Schlapp

4073 FREE-VOLUME MODEL OF THE AMORPHOUS PHASE: GLASS TRANSITION. D.Turnbull and M.H.Cohen.
J. chem. Phys. (USA), Vol. 34, No. 1, 120-5 (Jan., 1961).

Free volume v_f is defined as that part of the thermal expansion, or excess volume $\Delta\bar{v}$ which can be redistributed without energy change. Assuming a Lennard-Jones potential function for a molecule within its cage in the condensed phase, it can be shown that at small $\Delta\bar{v}$ considerable energy is required to redistribute the excess volume; however, at $\Delta\bar{v}$ considerably greater than some value $\Delta\bar{v}_g$ (corresponding to potentials within the linear region), most of the volume added can be redistributed freely. The transition from glass to liquid may be associated with the introduction of appreciable free volume into the system. Free volume will be distributed at random within the amorphous phase and there is a contribution to the entropy from this randomness which is not present in the entropy of the crystalline phase. According to this model, all liquids would become glasses at sufficiently low temperature if crystallization did not intervene. Therefore whether or not a glass forms is determined by the crystallization kinetic constants and the cooling rate of the liquid. The experience on the glass formation is consistent with the generalization: at a given level of cohesive energy the glass-forming tendency of a substance in a particular class is greater the less is the ratio of the energy to the entropy of crystallization.

4074 RECENT PHYSICAL INVESTIGATIONS ON HIGH POLYMERS.
H.Hendus, G.Schnell, H.Thurn and K.Wolf.
Ergeb. exakt. Naturwiss. (Germany), Vol. 31, 220-380 (1959).
In German.

Review article. Mechanical-dynamic, dielectric and nuclear resonance measurements; results of infrared investigations; X-ray and electron-microscope investigations of structures.

4075 INFLUENCE OF PRESSURE ON THE PROCESS OF COALESCENCE AND "HEALING" OF MICROPORES IN CRYSTALLINE BODIES. Ya.E.Geguzin.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 4, 829-32 (Dec. 1, 1960).
In Russian.

The coalescence of small pores into larger ones is examined theoretically in relation to a diffusion mechanism and the pressure dependence of the process is established. Experiments on single crystal NaCl and polycrystalline Cu confirm the pressure dependence; in the case of Cu, size distribution curves are determined for the pores produced under various pressures. [English translation in: Soviet Physics--Doklady (USA)]. R.F.S.Hearman

Surfaces . Films . Adsorption

4076 EXCHANGE REACTIONS INVOLVING SURFACE REGIONS IN SODIUM CHLORIDE CRYSTALS.
L.G.Harrison, I.M.Hoodless and J.A.Morrison.
Disc. Faraday Soc. (GB), No. 28, 103-12 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961).

An experimental study was made of halogen exchange between halogen gases and sodium chloride crystals using a tracer technique, which consists of following the appearance in the gas phase of the radioisotope Cl^{36} orginally incorporated in the solid. Results are given for exchange between hydrogen chloride and particles of sodium chloride prepared by volatilization in nitrogen, and for exchange between chlorine or bromine and films of sodium chloride prepared by evaporation under high vacuum. The reactions with hydrogen chloride in the temperature range −65° to 71°C appear to follow first-order kinetics initially. While in this respect they are similar to reactions with chlorine observed previously, their rate constants show different temperature and pressure dependences. The reactions of chlorine with the evaporated films are more rapid and more extensive and are adequately described by simple rate laws of the form $C = at^{1/n}$. The parameter a correlates with mass, and not with the surface area, of the films. The exchange with bromine appears to be almost instantaneous and does not exceed the equivalent of one surface layer. Possible mechanisms for the exchange reactions are discussed in a general way in terms of point imperfections in the solid.

4077 MICROTOPOLOGY OF THE SURFACE REACTIONS OF OXYGEN AND WATER VAPOUR WITH METALS.
E.A.Gulbransen and T.P.Copan.
Disc. Faraday Soc. (GB), No. 28, 229-33 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961).

The effect of dislocations, defects and internal stress on the physical properties of metals and alloys has been studied extensively. The effect of these factors on the chemical reactivity of metals has only recently been recognized. An electron optical study was made on the localized crystal growths formed when a pure grade of iron was oxidized in pure oxygen or pure water vapour at 400°C. Thin oxide whiskers 100-150 A in diameter form when pure annealed iron is reacted with dry oxygen. These whiskers may grow to lengths up to 500 000 A long. Thin blade-shaped platelets 100 A thick, 300 to 8000 A wide and 30 000 A long form when iron is reacted in water vapour at 400°C. Thin, rounded platelets of oxide 100 A thick, 75 000 A high and wide form when cold-worked iron is reacted with dry oxygen at 400°C. Electron optical studies of these localized crystal growths offer a new method for observing the effect of crystal imperfections in the chemical reactivity of metals.

4078 SURFACE STRUCTURES AND PROPERTIES OF DIAMOND-STRUCTURE SEMICONDUCTORS.
D.Haneman.
Phys. Rev. (USA), Vol. 121, No. 4, 1093-1100 (Feb. 15, 1961).

Low-energy electron-diffraction and secondary electron emission measurements were made on (111) and (111) surfaces of GaSb and on (100) surfaces of InSb. To account for the diffraction patterns observed both for these materials and previously for Ge and Si (Abstr. 7530 of 1959), a general model for (111) surfaces of diamond-structure semiconductors is proposed. Every second atom, counting along alternate close-spaced rows, is raised with respect to its neighbours, being bonded to the sublayer by three p bonds while the "dangling bond" is s type. The remaining three-fourths of the surface atoms have dangling p bonds and are bonded to the sublayer by trigonal sp^2-type bonds. The Ga or (111) face of GaSb has maximum sticking of 10^{-5} and 10^{-4} for oxygen and CO_2, respectively, these values being 10 times greater than those found for the Sb or (111) face. Multilayer adsorption of oxygen takes place on all the surfaces measured. The oxygen can be removed by heat treatment alone. Evidence is presented to show that diffusion of oxygen into the bulk is an important mechanism for regenerating the clean surfaces by heat treatment. Carbon dioxide absorbs on GaSb so as to show structure. It apparently deposits as an unbroken molecule, andm unlike oxygen, does not build up several layers.

4079 THE PREPARATION OF THIN FILMS OF GERMANIUM AND SILICON. B.A.Irving.
Brit. J. appl. Phys., Vol. 12, No. 3, 92-3 (March, 1961).

Films about 1000 A thick, suitable for observing dislocations by

transmission electron microscopy, have been prepared from the brittle semiconductors germanium and silicon by a combination of mechanical polishing and chemical etching.

4080 DIRECT OBSERVATION IN THE ELECTRON MICROSCOPE OF OXIDE LAYERS ON ALUMINUM.
K.Thomas and M.W.Roberts.
J. appl. Phys. (USA), Vol. 32, No. 1, 70-5 (Jan., 1961).

Using a modified technique of transmission electron microscopy, the properties of oxide films formed on aluminium foil by heat treatment in various oxidizing atmospheres at temperatures from 400° to 600°C were studied. Above 400°C, crystalline oxide forms by nucleation and growth, and has a basically f.c.c. lattice of parameter 7.9 ± 0.15 A.

4081 AN ELECTRON DIFFRACTION STUDY OF THE Ag—Sb SYSTEM IN THIN FILMS.
Li Sen-Dzhun [Li Seng-jung] and Z.G.Pinsker.
Kristallografiya (USSR), Vol. 5, No. 2, 228-32 (March-April, 1960).
In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 2, 211-15 (Sept.-Oct., 1960).

The structures of films in the Sb concentration range from 0 to 50% were studied. In agreement with X-ray results, the existence of an α-phase, a disordered hexagonal ϵ-phase and an ordered orthorhombic ϵ'-phase with lattice constants close to those of the orthohexagonal cell of the ϵ-phase were established.

4082 ACTION OF LIGHT ON THE GAS ADSORPTION BY SOLIDS. A.Terenin and Yu.Solonitzin.
Disc. Faraday Soc. (GB), No. 28, 28-35 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). Specific photodesorption effects, not due to heating by light, have been previously observed for CO adsorbed on Ni and for H_2O on Cd and Zn, but not on Bi and Sb (Valnev, 1956). Oxygen is photodesorbed from ZnO with Zn excess. Photosorption of O_2 and of CO takes place on ZnO with oxygen excess. A strong photosorption of oxygen by well-degassed silica gel was found, and interpreted as due to the splitting-off of surface hydroxyls by the ultraviolet light.

4083 KINETIC AND EXPERIMENTAL BASIS OF FLASH DESORPTION. G.Ehrlich.
J. appl. Phys. (USA), Vol. 32, No. 1, 4-15 (Jan., 1961).

Techniques are developed for deriving both qualitative and quantitative information on the kinetics of gas desorption from measurements at continuously changing temperature. First- and second-order processes can be distinguished immediately by the constancy of the end point of the former. Quantitative values for activation energy and frequency factors are deduced from the experimental time-temperature curve and the instantaneous slopes of the evolution curve, even for systems with concentration-dependent rate parameters. It is shown that for multiple desorption peaks qualitative detection is simplified by slow heating, but may result in interconversion. The experimental basis of desorption measurements using the Bayard—Alpert gauge is also analysed, together with artifacts arising from negative pressures, bistable gauge operation, formation of new species in the gauge, and the delay in sensing density pulses transmitted through tubes.

4084 THE ADSORPTION OF HYDROGEN AT GRAPHITE. W.J.Thomas.
J. Chim. phys. (France), Vol. 58, No. 1, 61-9 (Jan., 1961).

Experiments are described on the absorption of hydrogen by degassed graphite at different temperatures and show active adsorption to occur between 600-750°C and rapid chemisorption at −196°C. From a simple model it appears that the total number of bound carbon atoms calculated from the rate of chemisorption at −196°C is of the same order as that afforded by the X-ray method. The rate of adsorption in the range 600-750°C is too great for interpretation as a simple function of attack on free carbon atoms. After elimination of surface oxygen (by reacting the graphite with carbon monoxide at 500°C), the supplementary amount of hydrogen adsorbed at 700°C corresponds to the replacement of one oxygen by two hydrogen atoms. The results are discussed on the assumption of two types of adsorption site. H.H.Hodgson

4085 STRUCTURE OF MONOLAYERS OF ADSORBED GASES. L.H.Germer and C.D.Hartman.
J. Phys. Chem. Solids (GB), Vol. 14, 75-6 (July, 1960).

Diffraction patterns of low energy electrons produced by a crystal surface have been accelerated sufficiently to show on a fluorescent screen where they can be photographed. Initially a (111) face of a nickel crystal was used. Nitrogen, oxygen, hydrogen, and carbon monoxide have been admitted to the system, by means of Granville-Phillips valves, to be adsorbed on the crystal face. CO and N_2 gave monolayers, the former with a high sticking probability, the latter with a low probability; O_2 gave a layer several atoms thick; H_2 gave no diffraction pattern itself, but improved the Ni Laue pattern. It is intended to study adsorbed gases on semiconductor single-crystal faces. R.V.Coates

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

4086 EFFECT OF EXTINCTION ON THE INTENSITY OF THE BACK REFLECTION IN X-RAY DIAGRAMS OF COLD-DEFORMED METALS. O.N.Shivrin.
Fiz. Metallov i Metallovedenie (USSR), Vol. 6, No. 4, 682-5 (1958).
In Russian.

A study is made of variation in the intensity of back reflections in X-ray diagrams of brass, copper, aluminium and steel under conditions of cold deformation. An increase in intensity of the (331) and (420) lines was at first observed during static compression of brass and copper test specimens. When a definite value of the residual deformation was reached, the intensity dropped during further deformation. Analogous test on aluminium showed a uniform rise in the intensity of lines (422) and (511) over the whole interval of residual deformation values used. The reduction in intensity of the (220) line found at the surface of cold-worked (polished) steel test specimens after the surface layer was removed, stops at a distance of 50 μ from the surface. These phenomena can be explained by the presence of two effects acting in opposite sense on the line intensity: the development of third order distortions and secondary extinction associated with block fragmentation. [English translation in: Phys. Metals and Metallography (GB), Vol. 6, No. 4, 100-4 (1958)].

4087 THE IDENTIFICATION OF PRECIPITATE PARTICLES IN SINGLE CRYSTALS OF SILICON BY REFLECTION ELECTRON DIFFRACTION. R.C.Newman.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 993-6 (Dec. 1, 1960).

Samples with about 3×10^4 dislocation lines per cm^2 were annealed below 1150°C and after suitable etching showed a diffraction pattern which it is suggested is due to particles of β-silicon carbide and a weaker pattern tentatively identified with λ-aluminium oxide. The particles were not present when specimens were annealed above 1250°C. J.E.Caffyn

4088 HEATING OF METALLIC FOILS IN AN ELECTRON MICROSCOPE. B.Gale and K.F.Hale.
Brit. J. appl. Phys., Vol. 12, No. 3, 115-17 (March, 1961).

The temperature of a thin metal foil illuminated by the high intensity electron beam of the modern microscope may at the centre of illumination reach a temperature above that of the melting point of iron. An attempt has been made to measure and calculate the temperature distribution for any given metal under various illumination conditions and to determine also the stress fields produced in the foil by such temperature distribution.

4089 ELECTRON MICROSCOPE OUT-OF-FOCUS IMAGE OF THE EDGE OF A CRYSTAL LATTICE.
H.Hashimoto and H.Watanabe.
Nature (GB), Vol. 188, 571-2 (Nov. 12, 1960).

Three extra fringes were observed in an out-of-focus electron image of a copper phthalocyanine crystal, as compared with the in-focus image. Experiments with a light optical analogue show that these lines are due in part to the divergence of the overlapping electron waves which emerge from the lattice, and in part to Fresnel diffraction at the edge of the crystal. V.E.Cosslett

4090 THEORETICAL LIMITING THICKNESSES FOR SINGLE SCATTERING IN ELECTRON MICROSCOPY.
N.R.Silvester and R.E.Burge.
Nature (GB), Vol. 188, 641-3 (Nov. 19, 1960).

Accurate measurement of mass-thickness (w), by electron densitometry, can be made only in the range over which contrast ($\log_n I_0/I$) is directly proportional to w. A discrepancy in magnitude exists between the experimental results and the theoretical estimates of the limiting value (w_{lim}) of the upper end of this range. The definition of w_{lim} used by different authors are examined, a system of symbols for the theoretical parameters is suggested and some errors in the literature in calculating values of w are exposed. In particular, two differences between the treatment of Leisegang (Abstr. 7329 of 1952) and that of Lenz (Abstr. 7490 of 1954) are analysed and as a result their predictions are reconciled. Part of the difference is due to a different choice of approximation to the electron charge distribution around the scattering atom, and part to an error in Leisegang's paper; owing to the latter error, the theoretical cross-sections calculated by a number of authors are about 30% too small. Finally, the definition of w_{lim} which most closely fits the physical conditions of electron microscopy is discussed. The proposal made is that it should be the theoretical mass-thickness for which the mean number of scattering acts per electron with a deflection greater than the aperture semi-angle (α) is unity, i.e., scattering processes with deflections smaller than α are to be neglected. V.E.Cosslett

4091 SPECIMEN TILTING DEVICE FOR USE IN THE HITACHI H.U. 10 ELECTRON MICROSCOPE.
M.C.Huffstutler, Jr and G.Thomas.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 86-8 (Jan., 1961).

A tilfing specimen holder is described. Its usefulness in transmission studies of the fine structure of metal foils is illustrated.

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

EQUILIBRIUM DISTRIBUTION OF ONE COMPONENT BETWEEN TWO LIQUID PHASES. ITS CONNECTION WITH INTERFACIAL PHENOMENA. See Abstr. 2741

TRANSFER OF MATTER BETWEEN TWO LIQUID PHASES. I. VELOCITY OF MIGRATION OF ONE COMPONENT THROUGH THE INTERFACE BETWEEN TWO PHASES. See Abstr. 2742

TRANSFER OF MATTER BETWEEN TWO LIQUID PHASES. II. DIFFUSION VELOCITY OF ONE COMPONENT BETWEEN TWO SEMI-INFINITE PHASES. See Abstr. 2743

TRANSFER OF MATTER BETWEEN TWO LIQUID PHASES. III. INFLUENCE OF SURFACE ACTIVE AGENTS ON THE TRANSFER VELOCITY. See Abstr. 2744

4092 CRITICALITY CRITERIA FOR VARIOUS CONFIGURATIONS OF A SELF-HEATING CHEMICAL AS FUNCTIONS OF ACTIVATION ENERGY AND TEMPERATURE OF ASSEMBLY. J.R.Parks.
J. chem. Phys. (USA), Vol. 34, No. 1, 46-50 (Jan., 1961).

In 1939 Frank-Kamenetsky proposed a criticality criterion that is a dimensionless constant that varies only with configuration of the self-heating chemical. In his studies of the equation equating power production as a function of temperature by the formula of Arrhenius and the power loss by conduction alone, he made a simplifying assumption. A Pace analogue computer and an IBM 704 have now been used to study the exact equation and it was found that the value of the F-K criticality criterion is a slowly varying function of E/RT_0 in the range from infinity to 30 but becomes a sensitive function for values of E/RT_0 less than 30.

4093 REACTIONS OF ACTIVE NITROGEN WITH HYDROGEN BROMIDE, BROMINE, AND ETHYLENE.
E.R.V.Milton and H.B.Dunford.
J. chem. Phys. (USA), Vol. 34, No. 1, 51-3 (Jan., 1961).

Measurement of the specific rate constant for the reaction $N + HBr \rightarrow NH + Br$ indicates that k is 3.8×10^{-14} sec^{-1} (molecules/cm^3)$^{-1}$ at 40° C. Attempts to obtain complete turbulence of reactants at a pressure of 0.85 mm were unsuccessful so that diffusion techniques were employed. The homogeneous flame reaction accompanying the above reaction was too weak to define the reaction zone, so calculations were based on the reaction tube diameter and the critical flow rates of reactants at which the orange flame initiated by a wall reaction involving active nitrogen and bromine was prevented. Spectra of flames obtained from the $N + Br_2$ and N + HBr reactions in a stirred-flow reactor indicate that NBr is the source of the orange flame in the latter reaction. The flow rates of atomic nitrogen were calibrated by chemical titration with ethylene. A conventional diffusion flame technique was used to obtain $k = 1.6 \times 10^{-13}$ sec^{-1} (molecules/cm^3)$^{-1}$ at 40° C for the reaction $N + C_2H_4 \rightarrow HCN + CH_3$.

4094 EXPERIMENTAL INVESTIGATION OF THE COMBUSTION OF TWO-PHASE MIXTURES IN A TURBULENT STREAM. B.P.Lebedev and V.G.Tikhomirov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 8, 994-1005 (Aug., 1960). In Russian.

For abstract, see Abstr. 18437 of 1960. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 5, No. 8, 929-37 (Feb., 1961)].

4095 EFFECT OF CHEMICAL REACTION ORDER ON FLAME PROPAGATION. J.O.Hirschfelder.
Phys. of Fluids (USA), Vol. 4, No. 2, 253-9 (Feb., 1961).

The properties of flames supported by one-step exothermal chemical reactions of from zero to third order are compared. New calculations are made for flames supported by second- and third-order reactions. The Adams—Wilde type of approximate solutions is obtained. The ignition temperature approximation is developed for zero- and second-order flames. Neither the Adams—Wilde nor the ignition temperature approximation is suitable for flames supported by high-order or complex systems of chemical reactions.

4096 ON A PROBLEM IN THE THERMAL STABILITY OF EXPLOSIVES.
M.P.Murgai, J.O.Milmoe, J.P.Kottenstette and F.L.Smith.
J. appl. Phys. (USA), Vol. 32, No. 2, 324-5 (Feb., 1961).

Numerical values of the explosion time of an explosive slab are obtained from an equation for heat conduction. The results are said to be consistent with those of Zinn and Mader, (Abstr. 5200 of 1960). E.R.Wooding

4097 EXISTENCE OF DETONATIONS FOR SMALL VALUES OF THE RATE PARAMETER. W.W.Wood.
Phys. of Fluids (USA), Vol. 4, No. 1, 46-60 (Jan., 1961).

The simplified, one-dimensional steady-state Navier—Stokes detonation problem formulated by Hirschfelder et al. (Abstr. 7584-5 of 1958; 4088 of 1959) is examined with respect to the existence of solutions when the reaction rate is small compared to the molecular collision rate. The latter condition is necessary for the assumed unimolecular mechanism to be valid, but is also the condition where these authors were unable to find solutions by numerical integration of the differential equations. It is shown that solutions indeed exist for arbitrarily small values of the reaction rate, and that these solutions approach the von Neumann model of a shock preceding a deflagration. An asymptotic approximation to the solution is given which should be adequate for such small reaction rates. In order to make the steady-state problem mathematically well defined, the usual difficulty of the very small reaction rate in the initial state is removed by imposing an ignition temperature. It is shown that if the reaction rate and Mach number are held fixed while the ignition temperature is raised slightly above the von Neumann spike temperature, the solution changes to a flame having the same hot boundary state, but with the detonation von Neumann spike state as its initial state.

LOW-DENSITY SHOCK TUBE FOR CHEMICAL KINETICS STUDIES. See Abstr. 2783

4098 IGNITION TEMPERATURE APPROXIMATION FOR BIMOLECULAR DETONATIONS.
J.O.Hirschfelder, C.F.Curtiss and M.P.Barnett.
Phys. of Fluids (USA), Vol. 4, No. 2, 260-1 (Feb., 1961).

The theory of detonations including the effects of transport properties is applied to a detonation supported by the bimolecular reaction 2 A → 2 B. For simplicity, the ignition temperature approximation is used and it is assumed that the Prandtl number is three-fourths and the Lewis number is unity. Very little difference is found between the properties of a bimolecular and a unimolecular detonation. However, because of the unrealistic nature of ignition temperature chemical kinetics, it is not possible to reach any conclusion regarding experimental gaseous detonations.

4099 DETONATION VELOCITY OF PRESSED T.N.T.
M.J.Urizar, E.James, Jr and L.C.Smith.
Phys. of Fluids (USA), Vol. 4, No. 2, 262-74 (Feb., 1961).

The detonation velocity was determined as a function of charge diameter at each of a series of loading densities ρ. Current theories of the diameter effect are discussed and used to compute infinite diameter detonation velocities (D_∞)and detonation reaction-zone lengths from the experimental data. The results for the velocity-density dependence may be summarized as follows: $D_\infty = 1872.7 + 3187.2\ \rho$,$(0.9 \leq \rho \leq 0.5342\ g/cm^3)$; $D_\infty = 6762.5 + + 3187.2(\rho - 1.5342) - 25\,102(\rho - 1.5342)^2 + 115\,056(\rho - 1.5342)^3$, $(1.5342 \leq \rho \leq 1.636\ g/cm^3)$. The reaction-zone lengths computed from the data are a decreasing function of the charge density and are in good agreement with predictions based on the grain-burning model of the reaction zone.

4100 LOW-TEMPERATURE CHEMISORPTION. I. FLASH DESORPTION OF NITROGEN. G.Ehrlich.
J. chem. Phys. (USA), Vol. 34, No. 1, 29-38 (Jan., 1961).

Flash desorption (desorption by continuous temperature displacement) is applied to a study of the low-temperature interactions of N_2 with an initially clean tungsten surface. Molecular nitrogen is found to dissociate into atoms on adsorption even at 115°K, at a rate which diminishes with increasing temperature, but is initially independent of surface concentration. Formation of this atomically bound β nitrogen is hindered at low temperatures ($T \sim 115$°K) by competitive growth of an additional state γ, in which nitrogen, at $\sim 2\frac{1}{2}$ times the concentration in the β state, is bound as molecules with an energy of 9 kcal mole^{-1}, resulting in a total surface concentration of 600×10^{12} molecules cm^{-2}. The population in this γ state depends sensitively upon the arrangement of atoms in the β state. Preadsorption at $T \sim 300$°K equalizes the populations in β and γ; annealing at $T \sim 1000$°K at impingement rates of 7×10^{15} molecules cm^{-2} min^{-1} further lowers n_γ/n_β and brings about rearrangement of the tungsten surface as well without appreciable change in the adatom concentration. A third state α is formed at temperatures up to 400°K, with a binding energy of ~20 kcal mole^{-1}. Initially its rate of formation, just as that of γ at low temperatures, is dictated by the concentration of the atomically held β state. At 300°K and above the α concentration passes through a maximum, then diminishes; at low temperatures, it remains constant, achieving a maximum value 1/30 that of the γ state.

4101 LOW-TEMPERATURE CHEMISORPTION. II. FLASH DESORPTION OF CARBON MONOXIDE. G.Ehrlich.
J. chem. Phys. (USA), Vol. 34, No. 1, 39-46 (Jan., 1961).

Flash desorption studies of the interaction of carbon monoxide with a tungsten surface indicate that this gas forms at an initial rate considerably higher than that for nitrogen (CO sticking coefficient: $s \sim 0.5$; N_2 sticking coefficient: $s \sim 0.25$). This rate also remains independent of the amount adsorbed for higher coverages, up to $n \sim 300 \times 10^{12}$ molecules cm^{-2}. Unlike nitrogen, CO does not dissociate on the surface. It retains its molecular identity in both the primary chemisorbed state β, and the weaker state of 20 kcal mole^{-1} binding energy α, which forms as the rate of β growth diminishes. At T = 298°K, the α state reaches a concentration of $\sim 200 \times 10^{12}$ molecules cm^{-2}. No additional weak binding is found even at low temperatures, $T \sim 115$°K. The β state is itself made up of three subpeaks, arising from different surface structures, and designated β_1, β_2, and β_3 in order of increasing binding energy. Only β_2 and β_3 form initially, with desorption energies of 75 and 100 kcal mole^{-1}, respectively; β_1 appears at higher coverages, at which the desorption energy of β_2 has also diminished.

4102 INFRARED METHODS APPLIED TO SURFACE PHENOMENA. R.P.Eischens.
J.Phys. Chem. Solids (GB), Vol. 14, 56-9 (July, 1960).

Outline of the experimental methods for observation of infrared spectra of chemisorbed molecules that have been applied to the study of catalysis, and discussion of their possible usefulness for studies of the surface chemistry of germanium and silicon. J.Hawgood

4103 BARIUM–CARBON MONOXIDE SYSTEM: AN HYPOTHESIS OF ARIZUMI AND KOTANI.
T.A.G.Giorgi and S.Origlio.
Brit. J. appl. Phys., Vol. 12, No. 3, 120-2 (March, 1961).

According to Arizumi and Kotani (see Abstr. 7090-5 of 1952) carbon dioxide may be formed from carbon monoxide owing to the catalytic action of a barium getter deposit. This hypothesis has been experimentally investigated using an ion resonance mass spectrometer of the omegatron type. It has been shown, using the dynamic sorption measuring technique at constant pressure on the getter film, that there is no such catalytic action. The results obtained indicate that the experimental behaviour observed by Arizumi and Kotani, and which warranted their hypothesis, is due to outgassing of the sealed-off system.

ELECTROCHEMISTRY

4104 THE INTERFACE BETWEEN A METAL AND AN ELECTROLYTIC SOLUTION. R.J.Watts-Tobin.
Phil. Mag. (GB), Vol. 6, 133-53 (Jan., 1961).

Measurements of the capacity of the electrical double layer at the interface between a polarizable mercury electrode and an aqueous solution of a strong electrolyte are interpreted theoretically. Attention is concentrated on the layer of charges at the actual phase boundary, whose behaviour has not been satisfactorily explained before. It is suggested that for anodic polarization an increasing number of mercury atoms is situated at adsorbed sites on an otherwise flat surface. These carry a charge, and lead to a rise in the measured capacity as the polarization becomes anodic. It is thus shown why the capacity as a function of polarization has a form for fluoride electrolytes, where there is no specific adsorption of the anion, so similar to that for other electrolytes, where there is. The behaviour of the water molecules in contact with the mercury is considered in some detail, and compared with the behaviour of bulk water and of a monolayer of water adsorbed to a mercury surface. It is shown that the hump, which appears in most capacity curves slightly to the anodic side of the electrocapillary maximum, may be due to the high polarizability of the water layer between the metal and the outer Helmholtz plane, when the field there is small. It is not necessary to assume as Grahame does that there is any appreciable chemical or image force polarizing the surface molecules, or that the water takes up a rigid ice-like structure for low fields. The suggestion that the rise in the capacity for cathodic polarization is due to compression of the double layer by electrostatic forces is also considered, with the implication of this idea on the mechanism of overvoltage in the discharge of cations onto mercury.

4105 ARRANGEMENT FOR ELECTROCHEMICAL POTENTIAL–TIME MEASUREMENT IN THE MILLIMICROSECOND RANGE.
E.Blomgren, D.Inman and J.O'M. Bockris.
Rev. sci. Instrum. (USA), Vol. 32, No. 11-12 (Jan., 1961).

The arrangement described allows potential–time measurements in galvanostatic pulse techniques to be performed 40-80 mμsec after initiation of the pulse.

DISPERSIONS . COLLOIDS

4106 INVESTIGATION OF THE EFFECT OF ULTRASONIC OSCILLATIONS ON THE DIFFUSION OF AN ELECTROLYTE IN A GELATIN GEL. M.E.Arkhangel'skii and G.N.Pinus.
Kust. Zh. (USSR), Vol. 6, No. 3, 278-83 (1960). In Russian.
The ultrasound intensity was 0.3 W/cm^2 and the frequency range om 500 kc/s to 9 Mc/s. The diffusion rate was measured from he motion of the front of the dyed electrolyte as observed by a icroscope. It is shown that a variable acoustic pressure acts directly to accelerate the diffusion process. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 3, 276-81 (Jan.-March, 1961)].

4107 SOME STUDIES OF AQUEOUS URANIUM OXIDE SLURRIES. R.S.Hansen, R.E.Minturn and B.H.Clampitt.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 458-60 (Nov., 1959).
It is pointed out that the preparation of aqueous slurries of uranium compounds in concentrations sufficiently great and of sufficient stability to be of interest as nuclear fuels offer an excellent illustration of colloidal principles. J.F.Hill

GEOPHYSICS

4108 VIBRATIONS OF ALL WAVELENGTHS IN THE EARTH. O.Meisser.
Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 961) p. 385-95. In German.
This is a brief review of seismic vibrations, including tides of he solid earth, ranging from a few centimetres to thousands of kilometres. Some simple fundamental considerations are mentioned and odern measuring techniques are described and illustrated by dispersion curves of continental and oceanic Rayleigh waves.
H.J.H.Starks

RADIOCARBON DATING SYSTEM USING SCINTILLATION ECHNIQUES. See Abstr. 2178

ATMOSPHERE

(Troposphere and Stratosphere)

4109 A METHOD FOR STUDYING THE DIFFUSION OF SILVER IODIDE PARTICLES IN THE ATMOSPHERE BY MEANS OF I^{131}. R.Carreras-Patxot and R.Sänger.
. angew. Math. Phys. (Switzerland), Vol. 9, No. 4, 375-80 Nov. 25, 1958).
An attempt to check the presence in air of silver iodide vapour sed to stimulate rain was carried out using a sample containing adioactive iodine 131. W.J.Orville-Thomas

4110 LIGHT SCATTERING IN THE EARTH'S ATMOSPHERE. G.V.Bozenberg.
spekhi fiz. Nauk (USSR), Vol. 71, No. 2, 173-213 (June, 1960).
Russian.
A review of present theories of light scattering in the earth's mosphere and the resulting phenomena of polarization, sky brightess, propagation in fog and cloud. 99 references. [English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 3, 346-71 (Nov.-ec., 1960)]. R.W.Fish

4111 ON THE QUESTION OF BALL LIGHTNING. P.A.Silberg.
. appl. Phys. (USA), Vol. 32, No. 1, 30-5 (Jan., 1961).
The hypothetical model of ball lightning first suggested by apitza (Abstr. 1771 of 1956) is considered in some detail in an ttempt to uncover evidence which will substantiate or contradict ne theory. Observers' reports of the phenomenon are summarized riefly. Pro and con arguments concerning Kapitza's scheme are iven. A theoretical model in an ideal environment is examined. he radio-frequency field suggested by Kapitza is considered, and ne interference effects resulting from the reflection of a discrete and spectrum of linearly polarized waves from a perfect reflector re presented. The gaseous discharge is discussed, under the ssumption that the ball lightning phenomenon is analogous to a oint-to-plane corona discharge. It is determined that, given a ufficiently intense electric field, a horizontal discharge along one f the electric field antinodes, suggestive of horizontal lightning, an result. It is concluded that this exploratory work supports apitza's hypothesis, but that much more must be done before the heory is fully substantiated.

4112 ON THE FREQUENCY OF LIGHTNING FLASHES TO HIGH OBJECTS. A STUDY ON THE GULF OF BOTHNIA. D.Müller-Hillebrand.
Tellus (Sweden), Vol. 12, No. 4, 444-9 (Nov., 1960).
The space-charge calculation of a lightning stroke according to Golde (Abstr. 2417 of 1946) results in a simple geometrical relation between the area within which a flash strikes an object and its height. A comparison between the number of lightning strokes to chimneys and the number of lightning downstrokes per km^2 shows that the statistical attraction distance of a 70 m high chimney is more than 250 m and thereby more than the leader's step-length after Schonland. An explanation may be the space-charge plume, which leaves the lightning rod in a thunderstormfield and may conduct a lightning discharge to the chimney from some hundreds of metres distance.

4113 THE LIGHTNING SPECTRA IN THE VISIBLE AND ULTRA-VIOLET REGIONS WITH GRATING SPECTROGRAPH. Hu Ren-Chao.
Science Record (China), Vol. 4, No. 6, 380-8 (June, 1960).
Photographic observations at high aperture (f/0.8 and f/1.2) and good dispersion (100A/mm) of the lightning spectrum over the wavelength range 2750-7000A have led to the identification of lines of N I, N II, O I, O II, and H I and of bands of N_2^+, N_2, OH, NH, and H_2O. R.W.Nicholls

4114 PROPAGATION OF WHISTLERS TO POLAR LATITUDES. G.McK.Allcock.
Nature (GB), Vol. 188, 732-3 (Nov. 26, 1960).
A statistically significant association was found between the occurrence of whistlers at Scott Base, Antarctica, and at stations in New Zealand. Detailed consideration of the dispersion characteristics of a coincident whistler which occured on April 7, 1959, together with meteorological data, strongly suggests that the source on this occasion was a local thunderstorm area in the middle of the Tasman Sea. Sonagrams of short whistlers recorded simultaneously in the USA also suggest that this whistler was a true middle-latitude one, with propagation paths terminating in middle latitudes. This supports Martin's theory that polar whistlers originate in lower latitudes and are propagated to polar regions by reflection between the earth and the lower ionosphere. G.M.Brown

4115 ULTRA-LOW-FREQUENCY ATMOSPHERICS. H.König.
IRE internat.Convention Record (USA), Vol. 8, Pt 1, 128-33 (1960).
The earth and the ionosphere together form a spherical-type resonant cavity. The natural frequency of this resonator was calculated by Schumann (see Abstr. 7413 of 1952) to be approximately 10 c/s. In order to test this result, it was decided to determine experimentally whether or not there might actually exist in the atmosphere signals which would lie within this frequency range, and to investigate the effects of such signals on living organisms.

4116 ENERGY FLUXES FROM THE CYCLOTRON RADIATION MODEL OF V.L.F. RADIO EMISSION. R.A.Santirocco.
Proc. Inst. Radio Engrs (USA), Vol. 48, No. 9, 1650 (Sept., 1960).
It has been suggested tham some audio-frequency electromagnetic background radiations, in particular the "dawn chorus", are due to cyclotron radiation from protons incident on the exosphere. Calculations suggest that the energy flux resulting from this mechanism will only be of the order of 10^{-16} W/m^2, even when

the most propitious circumstances are assumed. This is much less than the background flux to be expected from sferics, and in consequence the cyclotron radiation model seems to fail. It is suggested that the travelling-wave-tube mechanism proposed by Gallet may provide a more satisfactory explanation (see Abstr. 7213 of 1959). G.D.Sims

4117 PROPAGATION OF THE RADIATION FROM Co^{60} IN AIR ABOVE THE EARTH.

O.I.Leipunskii and V.N.Sakharov.
Atomnaya Energiya (USSR), Vol. 6, 585 (1959). In Russian. [English translation in: Reactor Science (GB), Vol. 12, No. 4, 209-10 (Aug., 1960)].

Reports measurements of the attenuation of the radiation from Co^{60} in air above the earth at distances from 1 to 800 m from a source. The results are compared with those calculated theoretically and with those obtained from a model experiment in water. C.F.Barnaby

RADIOACTIVE FALLOUT IN THE LENINGRAD REGION. See Abstr. 3400

ESCAPE OF PLANETARY ATMOSPHERES. See Abstr. 2600-1

UPPER ATMOSPHERE IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

4118 ON THE DETERMINATION OF THE TRUE HEIGHT OF THE MAXIMUM OF IONIZATION BY THE TEN-POINTS METHOD. A.Haubert.
J. atmos. terrest. Phys. (GB), Vol. 18, No. 4, 337-9 (Aug., 1960). In French.

The paper describes a graphical construction method for determining the true height of the maximum of ionization, from the curve of true height plotted against frequency (obtained by the ten-points method) as far as the neighbourhood of the critical frequency. A.Boksenberg

4119 V.L.F. SPECTRA OF ATMOSPHERICS PROPAGATED THROUGH THE IONOSPHERE. T.Obayashi.
Rep. Ionosphere Res. Japan, Vol. 12, No. 4, 478-82 (1958).

This note presents results obtained with a radio spectroscope which provides continuous swept-frequency recordings over the ranges 1 - 10 kc/s and 5 - 70 kc/s. The statistical distribution of amplitude with frequency is determined by observation of a large number of atmospherics, but the spectra of individual atmospherics are not studied. Examples of the records are reproduced. The daytime spectrum has a peak at about 15 kc/s; the night spectrum has a main peak at 8 - 10 kc/s and subsidiary peaks at higher frequencies. An "absorption band" exists at 2 - 4 kc/s. The observations support the "waveguide mode" theory of ionospheric v.l.f. propagation. Some diurnal variations, and effects observed during a solar flare and associated "SEA", are discussed in terms of mode theory. H.Rishbeth

4120 CONTRIBUTION TO THE STUDY OF IONOSPHERIC ABSORPTION AT A FIXED FREQUENCY. II.

G.Pillet.
Ann. Telecomm. (France), Vol. 15, No. 9-10, 198-219 (Sept.-Oct., 1960). In French.

The theory and apparatus used in this study have been described in a previous paper [Abstr. 8268 B of 1960; Ann. Telecomm. (France), Vol. 15, No. 7-8, 157-84 (July-Aug., 1960)]. Curves are given and experimental points are indicated for a number of absorption measurements made including the following: the diurnal variation of the total absorption, showing the characteristic variation in each month over a period of two and a half years; the variation of absorption with solar zenithal angle for several months in the year 1956; the seasonal variation in absorption, and the mean monthly absorption for a fixed zenithal angle. Curves are also included of the rapid fluctuations in the echo magnitudes and of the mean monthly fluctuation indices. The correlation between these latter and magnetic disturbances has also been studied. The measurements were mostly made at Poitiers or Domont, for vertical incidence at frequencies of 2-4 Mc/s and the characteristics and implications of the curves are fully discussed in each case. Some of the more important conclusions were given in Pt I. G.D.Sims

4121 IONOSPHERIC INFORMATION FROM SATELLITE SIGNALS. G.H.Munro.
Nature (GB), Vol. 187, 1017-18 (Sept. 17, 1960).

Observations of the rate of "Faraday fading" of radio signals from artificial satellites, made at a series of transits, can give information about day-to-day and seasonal variations of the F-layer, even if accurate calculations of electron density are not attempted. Suggestions are made about the most suitable satellite orbits and types of transmission. Over a period of two years, Faraday fading rates of satellite signals in the 20 Mc/s band have been recorded in Australia. The seasonal variations of electron density in the F-layer at night are discussed, and compared to those found from ionosonde data. An abrupt change of night-time electron density took place during September 1958, and seems to be related to observations of travelling disturbances (Abstr. 5537 of 1958); a reversal of the north-south component of drift at this time of year is suggested. H.Rishbeth

4122 ON SOME DISTURBANCES IN THE E-REGION. B.J.Robinson.
J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 160-71 (Dec., 1960).

Some common interpretations of features on E-region h'(f) curves have been compared with the behaviour deduced from the shape of the layer [N(h) curves], determined from high-resolution h'(f) curves. It is shown that the current distinction between "abnormal E" and "E2", on the basis of the group retardation observed, may not be tenable. Two well-known cases of moving disturbances on the h'(f) curve are found to be due to a redistribution of the ionization in the layer. It is also shown that the international definition of f_0E does not always give a reliable estimate of the maximum electron density when the h'(f) curve has a complex shape

4123 A FOURIER ANALYSIS OF WINDS IN THE LOWER E-REGION. E.L.Neufeld.
Jodrell Bank Ann. (GB), Vol. 1, No. 6, 267-73 (Nov., 1960).

A table of prevailing, diurnal and semi-diurnal components of wind velocity, based on radar observations of meteor trails made at Jodrell Bank (Abstr.7916 of 1954; 5791 of 1955; 2869 of 1957). The data cover one hundred 24-hour periods from 1953 to 1957, and refer to a mean altitude of 92 km. H.Rishbeth

4124 LEFT-HANDED IONOSPHERIC ECHO FROM AN EQUIVALENT HEIGHT OF (E + F).

S.R.Khastgir and Y.S.N.Murty.
J. sci. industr. Res. (India), Vol. 18 B, No. 7, 304-5 (July, 1960).

In 1956 Satyanariya and others reported experiments made in the night and early morning hours with a 3 Mc/s pulsed transmission directed vertically. The experiments suggested a new type of left-handed echo from the Es and F regions with an equivalent height of 2F—E. The authors of this paper discuss what happens to the two parts of the ordinary component of a vertically directed wave after reflection and transmission in the Es region: they conclude that the most likely path would lead to a reception at the ground of a left-handed echo with an equivalent height E + F . J.M.Stagg

4125 HORIZONTAL DRIFT IN THE IONOSPHERE OVER DELHI. S.N.Mitra, K.K.Vij and P.Dasgupta.
J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 172-83 (Dec., 1960).

Some results obtained at Delhi on the measurement of ionospheric drift by spaced receiver technique are described. Most probable velocities of reflections from the F- and E-layers for different seasons are indicated by histograms. The diurnal variations of the magnitude and direction of the drift velocity have been plotted graphically. Harmonic analyses of the east—west and north—south components of the drift velocity have been worked out. No predominant periodicity in any of the components was observed. It is interesting to note that the most probable direction of the drift velocity is towards the south, and the northward component is almost completely inhibited. During magnetic storms, however, the northward component increases and its variation appears to be well correlated with the variation of the K index.

4126 THE HIGHEST PARTS OF THE IONOSPHERE. J.A.Ratcliffe.
art. J. Roy. Meteorol. Soc. (GB), Vol. 85, 321-31 (Oct., 1959).
A review of knowledge about the F region. Experimental ethods of determining the electron density in the upper ionosphere e enumerated, and the main features of the behaviour of the layer are discussed in terms of present theories. H.Rishbeth

4127 EQUATORIAL SPREAD-F AND F-LAYER HEIGHTS. A.J.Lyon and N.J.Skinner.
ture (GB), Vol. 187, 1086-8 (Sept. 24, 1960).
Earlier work on the correlation between the occurrence of read-F and magnetic disturbance (Abstr. 7627 of 1958) has been tended to cover a twelve month period during the I.G.Y., using ta for sixty ionospheric stations. The data are divided between ee seasons in two zones of longitude, and the results for these e broadly similar, with differences of detail. Within an equatorial lt (between magnetic latitudes $\pm 20^0$) the occurrence of spread-F reduced during magnetic disturbance; but at higher latitudes, the enomena are positively correlated, the transition occurring near gnetic latitudes $\pm 30^0$. Studies are also made of the greatest value ained, during the six hours following sunset, by the virtual height F of the F-layer. The variations of this quantity with magnetic itude closely resemble the distributions of spread-F incidence. e relation to theories of spread-F is briefly discussed.
H.Rishbeth

4128 A CONNEXION BETWEEN P_C AND THE F REGION. H.J.Duffus.
ture (GB), Vol. 188, 719-21 (Nov. 26, 1960).
Preliminary consideration of the relationship between the rmonic content (ratios of 12 hr/24 hr and 8 hr/24 hr components) the diurnal variation of the occurrence of geomagnetic micro-lsations of type P_C, and of the ionospheric electron density at 0 km, shows that provided a P_C source with 24 hr periodicity is stulated there is an inverse connection between the diurnal riation of P_C and that of N (280 km) for the equatorial zone. The mplest explanation of the results requires the source of P_C cillations to lie above the ionosphere, lending support to the eory that P_C pulsations originate as standing hydromagnetic waves the outer atmosphere. G.M.Brown

4129 OBSERVATIONS OF DAY AIRGLOW DURING THE SOLAR ECLIPSE. H.Tanabe and T.Tohmatsu.
p. Ionosphere Space Res. Japan, Vol. 13, No. 4, 290-3 (Dec., 59).
Observations are reported on the O I 5577 and 6300 A and I 5893 A components of the day airglow during the solar eclipse Oct. 12, 1958. A Lyot-type quartz birefringent filter was used the photometer at the Surarov Islands. No abnormal enhance-ent of the emissions was recorded. R.W.Nicholls

4130 VARIATION OF THE RATIO OF THE INTENSITIES OF THE ATMOSPHERIC SODIUM D LINES DURING WILIGHT. Nguyen-Huu-Doan.
R. Acad. Sci. (France), Vol. 251, No. 25, 3031-3 (Dec. 19, 1960). French.
Measurements made photographically with a grating spectro-raph of adequate resolution (dispersion 48 A/mm at 5893 A) reveal systematic change during mid-twilight of the emission intensity tio D_2/D_1 from a value of 1.0 at solar Z.D. 97^0 to 1.4 at Z.D. 100^0, ter taking account of the Fraunhofer absorptions, and adopting lues of 0.067 and 0.056, respectively, for the residual central tensities of the D_1 and D_2 components. D.R.Barber

4131 CORRELATIONS BETWEEN INTENSITIES OF VARIOUS RADIATIONS OF THE NIGHT ATMOSPHERIC LUMIN-SCENCE. D.Barbier and J.Glaume.
n. Geophys. (France), Vol. 16, No. 1, 56-76 (1960). In French.
An eight colour photometer has been in use at Haute-Provence nce July 1953 and the radiations from 6700, 6300 (narrow) 00 (broad) 5900, 5577 4400 and 3670 A in the night airglow have en continuously monitored. Radiations from OH, O I, OH, Na, I, O_2 and O_2 are respectively passed by the filters. A very strong rrelation between the intensities of the last four of these is re-rded together with a very small correlation between these and the st four. Correlations between the O I green line (5577 A), the rzberg Bands of O_2, (4400 A and 3670 A) and a continuum are oretically explained. R.W.Nicholls

4132 OBSERVATIONS OF AURORAE BY RADAR IN TERRE ADÉLIE (NOVEMBER 1957 TO JANUARY 1958). K.Bullough.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2222-3 (Nov. 14, 1960). In French.
Radar echoes on a frequency of 73 Mc/s have been obtained during the southern summer at Dumont d'Urville (66^0 40' S, 140^0 01' E) from all directions and from distances as great as 1350 km. A study of the distribution and characteristics of the activity indicates a division into four sectors of geomagnetic hour angle (day, begining of evening, end of evening, night), and two zones (geomagnetic colatitudes $<16^0$ and $\geq 16^0$). There appears to be a relation between the planetary index K_p and the geomagnetic colatitude of an auroral group. G.M.Brown

AURORAL ACTIVITY, 1960 APRIL 27-30. See Abstr. 2606

DISTRIBUTION OF DENSITY IN A PLANETARY EXOSPHERE. See Abstr. 2602

4133 THE ORIGIN OF THE OUTER RADIATION BAND OF THE EARTH. S.B.Pikel'ner.
Astron. Zh. (USSR), Vol. 36, No. 6, 1134 (1959). In Russian. English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 6, 1043-4 (May-June, 1960).
A short note proposing one of the possible mechanisms for an origin connected with geoactive streams. A.Boksenberg

SATELLITE OBSERVATIONS OF SOLAR COSMIC RAYS. See Abstr. 3305

MAGNETIC FIELD OF THE OUTER CORPUSCULAR REGION. See Abstr. 3306

RADIATION OBSERVATIONS WITH SATELLITE 1958 OVER AUSTRALIA. See Abstr. 3307

COMPOSITION OF THE EARTH'S CORPUSCULAR RADIATION AND POSSIBLE MECHANISMS OF ITS ORIGINATION. See Abstr. 3309

THE NATURE AND ORIGIN OF THE EARTH'S RADIATION BELTS. THEIR RELATION TO UPPER ATMOSPHERE DENSITIES AND THEIR GEOPHYSICAL EFFECTS. See Abstr. 3310

ON FAST CORPUSCULES OF THE UPPER ATMOSPHERE. See Abstr. 3311

TEMPORARY CAPTURE OF COSMIC RAY PARTICLES AND THEIR CONTRIBUTION TO THE HIGH INTENSITY BELTS. See Abstr. 3312

ON THE NATURE OF THE EXTERNAL RADIATION BELT OF THE EARTH. See Abstr. 3313

GEOMAGNETISM

4134 DAYTIME ENHANCEMENT OF THE AMPLITUDE OF GEOMAGNETIC SUDDEN IMPULSES IN THE EQUATORIAL REGION. H.Maeda and M.Yamamoto.
J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 284-7 (Dec., 1960).
The diurnal variation of the times of incidence of 110 sudden impulses in the geomagnetic field as recorded at 11 low latitude stations during the I.G.Y. is examined, and compared with the distribution of the times of incidence of sudden commencements at the same stations. Diagrams for each station show that there is a similar enhancement of amplitude in the impulses and commencements during the day time. It is inferred that essentially the same kind of mechanism produces both kinds of perturbation.
J.M.Stagg

4135 DETECTION OF TERRESTRIAL MAGNETIC FIELD FLUCTUATIONS IN THE FREQUENCY RANGE 5-50 c/s. R.Stefant.
C.R. Acad. Sci. (France), Vol. 251, No. 6, 857-9 (Aug. 8, 1960). In French.
A magnetometer consisting of five series-connected coils wound

on ferrite cores with axes parallel to the horizontal component of the terrestrial field and a galvanometer–amplifier with combined passband of 5-50 c/s were used. Continuous recordings of the spectrum were obtained by scanning this frequency range with a tuned twin-T network. The largest fluctuations, in the 20-40 c/s range, were diurnal and were attributed to the gyromagnetic resonance of Na in the upper atmosphere. A sharp decrease occurs at 15 c/s and a minor increase is observed near 5 c/s. S.Katz

4136 THE RELATION BETWEEN THE DELAY TIME OF GEOMAGNETIC DISTURBANCES AND THE RELATIVE SUNSPOT NUMBER. O.N.Mitropol'skaya.
Astron. Zh. (USSR), Vol. 37, No. 1, 63-6 (1960). In Russian. English translation in: Soviet Astron. -AJ (USA) Vol. 4, No. 1, 60-3 (July-Aug., 1960).

Using a statistical study of the central meridian passage (CMP) of Ca^+ plages, M-region geomagnetic disturbances and the Wolf sunspot number (R), it is demonstrated for the three periods, 1929-33, 1942-44, 1950-53, that the time of delay (Δ T) of an M-region disturbance with respect to the CMP of a Ca^+ plage depends on the level of spot activity (R) rather than on the actual phase of the eleven-year cycle. For spot numbers 10 and 100, the average values of ΔT are $\sim$ 7 and $\sim$ 4 days respectively. These results contradict Mustel's conclusion (Abstr. 21315 of 1960) that there is a coronal "zone of avoidance" for the M-particles. D.R.Barber

4137 DIPOLE-FIELD TYPE MAGNETIC DISTURBANCES AND AURORAL ACTIVITIES. B.K.Bhattacharyya.
Canad. J. Phys., Vol. 39, No. 2, 350-66 (Feb., 1961).

The characteristics of the magnetic field components at Agincourt were calculated for a current system produced by an electric dipole located in the region of auroral activity near Ottawa. It is noted that, irrespective of the orientation of the dipole, the horizontal magnetic field component rotates in the clockwise and anticlockwise senses for motion of the dipole towards the east and the west respectively, when the dipole is situated in the north half of the sky as seen from the observing station. Next, the magnetograms obtained at Agincourt were studied at those times of the night when auroral activity was recorded in the all-sky camera photographs at Springhill near Ottawa. It is noted that the horizontal magnetic field describes a loop during a particular phase of auroral activity because of its gradual growth and decay. The distributions of clockwise and anticlockwise rotations with respect to local time are found to be very similar in many respects to those of auroral motions to the east and west respectively. The sense of rotation of the loop is predominantly anticlockwise in the early part of the night and clockwise in the late hours of the night. It is found that eastward and westward orientations of the dipole are the most probable ones. The direction of movement and the initial location of the predominant auroral form in the sky are found to tally well with those of the dipole deduced from a study of the magnetograms. It seems that there is a time sequence relationship between successive phases of auroral activity and changes of characteristics of the loops described by the horizontal magnetic field vector. The area of a loop and the maximum magnitude of the field vector in the loop appear to be related to the brightness and horizontal extent of the auroral forms.

4138 DEMAGNETIZATION OF IGNEOUS ROCKS BY ALTERNATING MAGNETIC FIELDS.
E.Irving, P.M.Stott and M.A.Ward.
Phil. Mag. (GB), Vol. 6, 225-41 (Feb., 1961).

The presence of secondary components of magnetization in basalts often limits the usefulness of their directions of natural remanent magnetization for palaeomagnetic work. These secondary components may be removed by alternating magnetic fields. The procedures for doing this are described and tests based on the internal consistency of the results are devised to judge their reliability. These are applied successfully to a series of results from specimens collected from the Tertiary basalts of New South Wales, Australia, and a determination of the geomagnetic field in S.E. Australia during the Lower Tertiary is obtained. A study of the behaviour of these basalts in high alternating fields suggests that most of the iron mineral grains have a multi-domain character and contain a hard and soft component in the ratio of about 1 : 10.

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

4139 BIOPHYSICS IN THE MEDICAL CURRICULUM. J.E.Randall.
Amer. J. Phys., Vol. 28, No. 9, 801-4 (Dec., 1960).

As biology becomes a more quantitative and theoretical science, concerned with mechanisms at both the molecular and macroscopic levels, the physician will need to be familiar with the analytical concepts and techniques of physics. An approach to meeting this need with efficiency is that of teaching a course devoted to the more physical and theoretical aspects of biology as part of the medical curriculum. This paper describes how one such course has been organized and taught for the past five years.

4140 SERVO-OPERATED RESPIRATORY WAVEFORM SIMULATOR. D.W.Hill, J.R.Hook and E.G.Bell.
J. sci. Instrum. (GB), Vol. 38, No. 3, 100-2 (March, 1961).

An apparatus for the generation of typical respiratory patterns is described. Two pistons are driven by a half horse-power servomotor operated by a Velodyne speed control system. The desired waveform is produced by means of a cam or photoelectric function generator.

Hearing . Speech

4141 A SIMPLE SPEECH SYNTHESIZER. D.J.Woolons and A.M.R.Gill.
Electronic Technol. (GB), Vol.-37, No. 10, 373-5 (Oct., 1960).

A simplified apparatus is described in which two formant frequencies between 200 c/s - 1200 c/s and 1000 c/s - 2400 c/s are combined with a fricative noise source, larynx excitation and higher formant tones being dispensed with. Some original electronic circuitry and a co-ordinate control system for the two formant potentiometers are described. Intelligibility tests are claimed to give nearly 100% word and phrase identification.

M.L.Gayford

4142 VOICE LEVEL: AUTOPHONIC SCALE, PERCEIVED LOUDNESS, AND EFFECTS OF SIDETONE. H.L.Lane, A.C.Catania and S.S.Stevens.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 160-7 (Feb., 1961).

The speaker's numerical estimation of his own vocal level, the autophonic response, was found to grow as the 1.1 power of the actual sound pressure produced. When listeners judged the loudness of another speaker's vocalization (the phoneme [a]), the exponent was 0.7. The disparity between these exponents suggests that the speaker does not rely solely upon his perception of loudness in judging his own relative vocal level. The minor role played by loudness in the autophonic judgment is further demonstrated by the fact that the form and exponent of the subjective scale for autophonic responses remain relatively invariant under wide changes in auditory feedback. The power laws governing the autophonic response (exponent 1.1) and loudness (exponent 0.6) were used to predict successfully the outcome of cross-modality comparisons in which subjects tried to match their vocal level to sounds of various intensities presented either by loudspeaker or by earphone. The slope of the matching function, relating the criterion SPL to the vocal SPL in log-log coordinates, is given by the ratio of the two exponents. Unless the speaker tries deliberately to hold a constant level, the amount of sidetone gain with which the voice is fed back to the ears alters the voice level. The degree to which the speaker lowers his voice when the sidetone is increased is also predicted by the exponents governing the autophonic scale and the loudness scale.

4143 PITCH SYNCHRONOUS ANALYSIS OF VOICED SOUNDS. M.V.Mathews, J.E.Miller and E.E.David, Jr.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 179-86 (Feb., 1961).

A study of vowel sounds by means of a spectral analysis keyed synchronously to the voice pitch was carried out. Spectra are obtained by Fourier analysis of individual pitch periods which were established by visual inspection of oscillograms. A digital computer served as the analyser. The spectra are represented by a pattern of zeros and poles obtained by a process of successive approximation, again carried out by computer. The contributions from vocal tract and glottal source can be uniquely separated and examined. These results show that vowel sounds can be represented by a sequence of poles arising from the vocal tract and a sequence of zeros characterizing the glottal excitation. The frequencies of the vocal tract poles agreed with previous measurements, but the damping factors were not entirely consistent with earlier estimates. The zeros showed approximately uniform frequency spacing, particularly at high frequencies. A theoretical development indicated that this characteristic was to be expected from the known structure of the glottal excitation. The zero pattern was used to estimate the ratio of open-to-closed times for the glottis during voicing.

4144 FLOW REGULATION OF NEURAL PULSES IN THE AUDITORY SYSTEM. G.V.Gershuni.
Akust. Zh. (USSR), Vol. 6, No. 3, 299-306 (1960). In Russian.
English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 3, 298-305 (Jan.-March, 1960).

4145 INVESTIGATION OF MINIMUM PERCEPTIBLE DIFFERENCE INTERVALS BETWEEN TWO TONES. I.K.Samoilova.
Akust. Zh. (USSR), Vol. 6, No. 3, 381-8 (1960). In Russian.

To study the forms of masking in which signal and noise are separable in time, it is important to determine the minimum time interval necessary between two sounds, such that the weak sound does not become masked by the more intense one. The minimum perceptible difference intervals between two tones are investigated to see how they vary as a function of the frequency separation between signals, intensity of the masking sound, position of the masked and masking components on the frequency scale, and on the presence or absence of a functional tie between the two. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 3, 382-8 (Jan.-March, 1961)].

4146 CLASSIFICATION OF RAPIDLY REPEATED SPEECH SOUNDS. L.A.Chistovich.
Akust. Zh. (USSR), Vol. 6, No. 3, 392-8 (1960). In Russian.

The recognizability of sounds created upon rapid repetition, imitation, and phoneme discrimination of syllables was investigated. It is shown that the determinateness (with respect to phoneme classification) of sounds created on rapid repetition depends on the determinateness of the initial sounds. Indeterminate initial sounds generate sounds that are also indeterminate at the output. The same effect is observed on imitation. In the case of phoneme discrimination, indeterminate initial sounds generate fully determinate sounds at the ouput. It is concluded that rapid repetition of sounds comes to the same thing as their imitation. A two-stage scheme for speech discrimination is considered, which is based on preliminary imitation, then phoneme classification of samples of the articular movements used for their imitation. [English translation in Soviet Physics—Acoustics (USA), Vol. 6, No. 3, 393-8 (Jan.-March, 1961)].

4147 TEST OF RESPONSE BIAS EXPLANATION OF WORD-FREQUENCY EFFECT. C.R.Brown and H.Rubenstein.
Science (USA), Vol. 133, 280-1 (Jan. 27, 1961).

Observers identified monosyllabic words presented in noise. It was found that controlling response bias eliminates the word-frequency effect. However, the magnitude of the word-frequency effect was greater than that predicted by a mathematical model denying stimulus words any role in producing the effect.

4148 FORWARD AND BACKWARD MASKING BETWEEN ACOUSTIC CLICKS. D.H.Raab.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 137-7 (Feb., 1961).

The masking of one click by another was studied as a function of the time interval between the pulses. Two-alternative forced-choice procedures were employed to measure thresholds before and after the masking click. Both forward and backward masking were found; the forward effect was more pronounced and longer lasting. Backward masking studied in this way extends beyond what can be explained by peripheral intensity-latency conversions.

4149 BINAURAL INTERACTION OF CLICKS OF DIFFERENT FREQUENCY CONTENT. B.H.Deatherage.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 139-45 (Feb., 1961).

Results from previous experiments have suggested the notion that the neural information for the lateralization of brief sounds comes largely from the basal turn of the cochlea. An examination of that notion which uses stimuli at the two ears of different frequency content shows that the relation is not so simple. When stimulus clicks to the two ears are identical, then approximate simultaneity places a unitary click-image in the centre of the head; and when the stimulus click to one ear differs only moderately in frequency content from the click to the other, then a single click-image is still heard but the stimulus click of high-frequency content must be delivered later than the low-frequency click in order to place the image in the centre of the head. If the frequency difference is great, however, a unitary click-image is no longer heard. Instead, the sound breaks up into two images, one of high and one of low pitch, which may be independently brought to the median plane of the head by appropriate adjustment of the interaural temporal relation of the dichotic stimuli. Current auditory theory about localization and pitch neither predicts nor accounts for the presence of two such images.

4150 IMPROVED METHOD FOR STUDYING TYMPANIC REFLEXES IN MAN. E.S.Mendelson.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 146-52 (Feb., 1961).

This report describes manometric apparatus developed for registering the involuntary displacements of the human tympanic membrane during the reflex contraction of the middle-ear muscles. Recent tests with the new method were uniformly successful in 14 inexperienced subjects, as contrasted with only 20 out of 57 previously. The reflex reactions were also recorded from subjects who had been judged nonreactors in previous tests. Extensive repetitions of tests on one subject yielded a close quantitative relation between stimulus and response-index magnitudes. In this set of experiments the stimulus was a click-free tone of 500 c/s, graded in steps of 1 dB. The threshold sound pressure level was about 111 dB, and response magnitude rose in sigmoid fashion with progressively stronger stimuli.

4151 NETWORK MODEL OF THE MIDDLE EAR. A.R.Møller.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 168-76 (Feb., 1961).

The fine-structure acoustic-impedance curve of the ear obtained from normal humans in vivo is used to develop a network model of the middle ear. First a model representing the middle ear during stapedius muscle contraction is constructed, representing the middle ear with the stapes blocked. A further development adds a circuit corresponding to the input impedance of the cochlea as seen from the stapes. To decrease the influence of the eardrum itself, the eardrum was coated with collodion. Good agreement is found between the input impedance measured at the ear and calculated from the model over the range investigated, from 200 to 1800 c/s. The effect of the collodion coating is investigated and the earlier model is modified to fit the input impedance of the uncoated ear. The agreement is not so good as in the case of coated drum. The reason is suggested to lie in the complicated motion of the uncoated eardrum, which could not be represented by the simple circuit of the model.

4152 FACTOR ANALYSIS OF COCHLEAR INJURIES AND CHANGES IN ELECTROPHYSIOLOGICAL POTENTIALS FOLLOWING ACOUSTIC TRAUMA IN THE GUINEA PIG.
D.H.Eldredge, R.C.Bilger, H.Davis and W.P.Covell.
J. Acoust. Soc. Amer., Vol. 33, No. 2, 152-9 (Feb., 1961).

The changes in "threshold" and maximum responses for cochlear microphonic potentials and whole-nerve action potentials were measured following acoustic trauma with 500 c/s tones. The cochlear-microphonic responses were measured locally in the first turn of the cochlear for 500, 2000, and 8000 c/s test tones and locally in the third turn for a 500 c/s test tone. The whole-nerve action potentials were measured in response to 500 and 5000 c/s tone pips. Injury to the organ of Corti in the first and third turns was rated after examination of histological sections of the temporal bones. The physiological measurements, the injury ratings, and the sound pressures and durations of the traumatic exposures were examined together for correlations and analysed for common factors. The results served primarily to confirm previous conclusions. For durations of exposure from 5 to 80 min, equal total acoustic energy in the exposure produced equal changes in the electrophysiological responses. The ratings of anatomical injury in the cochlea departed significantly from this relation and tended to depend more strongly on sound pressure than on duration of exposure. The "threshold" shifts for CM responses from the first turn were the same for the three test frequencies, but loss of maximum potential was significantly different for the three test frequencies. The factor analysis grouped the whole-nerve AP responses to 500 c/s tone pips with the CM responses from the first turn instead of with the CM responses from the third turn.

Vision

4153 CURVATURE OF BINOCULAR VISUAL SPACE. AN EXPERIMENT. A.A.Blank.
J. Opt. Soc. Amer., Vol. 51, No. 3, 335-9 (March, 1961).

The sign of the curvature of any geometry is an intrinsic property independent of its coordinatization. Accordingly, it is possible in principle to determine the sign of the curvature of binocular visual space without employing knowledge of the particular relationship between the physical stimulus and the associated visual geometry. A simple experiment for making this determination is described and the outcome for a number of observers is presented. For most of the observers the indicated curvature is negative, in agreement with the preponderance of earlier findings.

4154 CATOPTRIC IMAGES AND THE PERIPHERAL MOVEMENT ILLUSION. C.T.White.
J. Opt. Soc. Amer., Vol. 50, No. 11, 1116-17 (Nov., 1960).

Apparent movement in the retinal periphery may be due to the corneal reflection of the fourth Purkinje image. R.A.Weale

4155 DURATION AND SIZE AS DETERMINANTS OF PERIPHERAL RETINAL RESPONSE.
E.Baumgardt and B.Hillmann.
J. Opt. Soc. Amer., Vol. 51, No. 3, 340-4 (March, 1961).

An experimental determination has been made of the effect of increasing size on the time interval over which the product of intensity and time is a constant. Past research with white-light stimuli has shown (I.t) constancy to break down at progressively shorter exposure times as the diameter of a circular test field is increased up to 3 deg. This experiment employed circular fields of red and blue-green monochromatic light centred in the peripheral retina 20 deg from the point of fixation. Thresholds for durations from 3.13 to 1000 msec and areas of 3.43 min, 1 deg, 3 deg, and 8 deg were obtained by the method of constants. The results for four subjects show that with both colors and all areas the product of threshold intensity and time is a constant for all exposure times up to 100 msec. This is in direct contradiction to previous findings. That these differences may depend on the spectral quality of the test light is discussed, as are the theoretical implications of the findings.

4156 SOME OBSERVATIONS ON THE OFF-EFFECT OF THE MAMMALIAN CONE ELECTRORETINOGRAM.
K.Tansley, R.M.Copenhaver and R.D.Gunkel.
J. Opt. Soc. Amer., Vol. 51, No. 2, 207-13 (Feb., 1961).

The "off"-effect of the pure-cone electroretinogram of the squirrel was studied by means of double-flash stimuli. It was found that as the stimulus intensity was increased there was often a depression of the "off"-effect, a phenomenon attributed by Granit to postexcitatory inhibition. When a second flash was superimposed on the normal "off"-effect, there was an enhancement of the a wave and a depression of the b wave of the second response. If the second flash were superimposed on a depressed high-intensity "off"-effect, the increase of the second a wave was much less and the depression of the second b wave greater than with a normal "off"-effect. These results confirm Granit's suggestion as to the nature of post-excitatory inhibition. There is apparently a reactivation of both

P II and P III at "off" in the pure-cone retina. The recovery of the wave after "off" follows an exponential course and may well be due to the decay of the suppression process recently postulated by Barden, Granit, and Ponte.

4157 ON-OFF INTERACTION IN THE HUMAN ELECTRORETINOGRAM. C.I.Howarth.
J. Opt. Soc. Amer., Vol. 51, No. 3, 345-52 (March, 1961).

The "off" response of the human electroretinogram is shown to resemble an inverted "on" response. The off response can only be obtained from a strongly light-adapted eye. The curve of response amplitude against length of stimulus flash passes through a maximum for flash durations of 12-20 msec, depending on the intensity of adaptation and stimulation. The curve of response amplitude against interval between two very short light flashes passes through a minimum for flash intervals of 15-25 msec under similar conditions of adaptation and stimulation. Algebraic addition of on and off responses or of two on responses is shown to provide an adequate explanation of the two curves.

4158 ELECTRONIC ANALOG OF THE HUMAN RECOGNITION SYSTEM. J.R.Singer.
J. Opt. Soc. Amer., Vol. 51, No. 1, 61-9 (Jan., 1961).

This article describes a system for pattern recognition made up of electronic logic elements which has many of the characteristics of humans for recognizing patterns. In particular, the recognition is invariant for size and will tolerate a specified amount of tilt or figure rotation. The electronic components or organs which make up this system consist of delay lines, logical elements such as "and" circuits, and photoreceptors.

4159 TRITANOPIA AND TWO-COLOUR IMAGE SYNTHESIS. A.Karp.
Nature (GB), Vol. 188, 40-2 (Oct. 1, 1960).

Further experiments are described which account for Land's two-colour effects within the framework of orthodox trichromatic theory. The observed effects are shown to be due to small-field tritanopia and a neutral point shift due to adaptation. R.A.Weale

4160 COMPUTER FOR THE CONVERSION OF TRISTIMULUS VALUES TO TRICHROMATIC COEFFICIENTS. B.W.Preston.
J. Opt. Soc. Amer., Vol. 50, No. 11, 1117-18 (Nov., 1960).

A simple potentiometer-controlled computer is described which enables one to perform the above operation, "errors experienced in computations by previous methods" being virtually eliminated. R.A.Weale

4161 OPPONENT CHROMATIC INDUCTION: EXPERIMENTAL EVALUATION AND THEORETICAL ACCOUNT. D.Jameson and L.M.Hurvich.
J. Opt. Soc. Amer., Vol. 51, No. 1, 46-53 (Jan., 1961).

The concept of physiologically based, opponent chromatic induction is fundamental to the opponent-colours theory. A continued quantitative development of this theory to account for colour perceptions, equations, and discriminations under various conditions of adaptation and illumination has emphasized the need for systematic quantification of induced colour effects. Experiments are reported in which a colour-matching technique was used to compare the chromatic responses to focal stimuli seen first in isolation and then in the presence of surrounding stimulus arrays of specified luminances and chromaticities and of various degrees of complexity. The results are analyzed in terms of the chromatic response processes of the opponent-colours theory. Chromatic inductions are shown to decrease systematically with decreasing contiguity of focal and surround stimulus areas. For given degrees of contiguity, induced chromatic responses are shown to be opponent to but proportional in magnitude to the mean chromatic activities of the inducing field, and the constant of proportionality decreases as a function of decreasing contiguity.

4162 VISUAL THRESHOLDS IN THE RETINAL PERIPHERY FOR RED, GREEN, AND WHITE SIGNAL LIGHTS. W.E.K.Middleton and G.W.Wyszecki.
J. Opt. Soc. Amer., Vol. 51, No. 1, 54-6 (Jan., 1961).

Experiments including the extreme periphery are reported. The method of adjustment was used to obtain the threshold for steady white, red, and green signals subtending an angle of 2.6 min at the observer's eye. Results are presented graphically.

4163 LUMINOSITY FUNCTIONS OF NORMAL, DEUTERANOMALOUS, AND DEUTERANOPIC SUBJECTS AS DETERMINED BY ABSOLUTE THRESHOLD AND C.F.F. MEASUREMENTS. W.E.Collins.
J. Opt. Soc. Amer., Vol. 51, No. 2, 202-6 (Feb., 1961).

Zeger's colorimeter, appropriately modified, was employed to determine the spectral sensitivity of one deuteranopic, two deuteranomalous, and two normal subjects. Absolute threshold data were collected using a 25 min field and constant flicker frequency curves were determined for both 50 min and 100 min fields. The sensitivity relationships among the subjects differed markedly depending upon technique, flicker rate, and field size. The results seem to indicate that the flicker situation provides a kind of information different from that obtained when absolute thresholds or visual acuities are studied. Research directed toward the relationship between flicker and absolute threshold measures of spectral sensitivity may provide important new data bearing on theories of colour vision and colour defect.

TECHNIQUE . MATERIALS

4164 DESIGN OF SCALES FOR INDUSTRIAL INSTRUMENTS. A.J.Maddock.
Brit. J. appl. Phys., Vol. 12, No. 2, 33-43 (Feb., 1961).

After discussion of the results of various experimenters on the errors that may arise when reading instrument scales and possible means of reducing them, attention is given to recommendations being prepared by the British Standards Institution. Particularly important is the relationship between size of scale and reading distance and the correlation with this of sizes and spacing of the graduation marks and numerals. An analysis of possible scale ranges and the subdivision of these to proceed in number steps of 1's, 2's or 5's, shows that the number is limited and not all can conform to the desired optimum conditions of design; compromise is therefore necessary particularly in the degree of accuracy to which the scale may be read. The scale designs considered are suitable for industrial instruments having accuracies to the order of 1 to 2%.

4165 ACTIVE-METAL SOLDERING OF CRYSTALLINE QUARTZ. M.E.Knoll.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 83-4 (Jan., 1961).

Very strong hermetic seals can be made to quartz crystals using a hydride of titanium or zirconium and a solder composed of copper-bearing lead or indium.

4166 NOTES ON A HIGH PRESSURE GAS APPARATUS. D.Langer and D.M.Warschauer.
Rev. sci. Instrum. (USA), Vol. 32, No. 1, 32-5 (Jan., 1961).

A hydrostatic high-pressure apparatus is described capable of achieving 18 kilobars at room temperature and 14.1 kilobars at 77°K, and which is limited in pressure at lower temperatures only by the freezing of helium. A number of techniques facilitating construction, operation, and repair are described. An experimental pressure vessel and cryostat for optical studies to 16 kilobars in the temperature range from 370° to ~60°K are also discussed.

4167 APPARATUS FOR THE PRODUCTION OF INERT GASES AT HIGH PRESSURES.
A.B.Dmitriev and N.P.Leven-Fisher.
Pribory i Tekh. Eksper. (USSR), 1958, No. 1, 109-16 (Jan.-Feb.). In Russian.

Describes the production of pure (< 0.001% impurities) He, Ne, A, Kr and Xe at pressures up to 75 atm and the fittings necessary for the use of these gases in the manufacture of electro-vacuum devices. [English translation in: Instrum. exper. Tech. (USA), No. 1, 122-8 (Jan.-Feb., 1958; publ. April, 1959)].

4168 URANIUM CARBIDE.
Nuclear Engng (GB), Vol. 5, facing p.354 (Aug., 1960).

Nuclear Engineering data sheet No. 15. A summary is given of the following properties of various U carbides (and, in a few instances, Pu carbides): density, melting point, boiling point, crystal structure, resistivity, thermal conductivity, thermal expansion, heat capacity, mechanical strength, modulus of elasticity, modulus of rupture, and hardness. Data are also given on thermodynamic properties and on phase diagrams, and a survey given of reactions with various solids. 77 refs. J.Thewlis

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Vol. 64 (1961). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Acta phys. chem. Szeged (Hungary)	Acta Physica et Chemica (Acta Universitatis Szegediensis) Szegedi Tudományegyetem Természettudományi Kara, Aradi Vértanuk tere 1, Szeged.
Ann. Tokyo Astron. Obs. (Japan)	Annals of the Tokyo Astronomical Observatory, University of Tokyo University of Tokyo, Mitaka, Tokyo.
Asea Res. (Sweden)	Asea Research Allmanna Svenska Elektriska AB, Västerås.
Atti Semin. Mat. Fis. Univ. Modena (Italy)	Atti del Seminario Matematico e Fisico dell'Universita di Modena. Modena.
Ergeb. exakt. Naturwiss. (Germany)	Ergebnisse der exakten Naturwissenschaften. Springer–Verlag, Berlin, Göttingen and Heidelberg. Orders to: Lange and Springer, Wissenschaftliche Buchhandlung, Heidelberger Platz 3, Berlin-Wilmersdorf.
Hausmitt. Jos. Schneider (Germany)	Hausmitteilungen Jos. Schneider & Co. Optische Werke, Kreuznach.
IRE Trans bio-med. Electronics (USA)	IRE Transactions on Bio-Medical Electronics (Formerly: IRE Transactions on Medical Electronics). Institute of Radio Engineers, 1 East 79th Street, New York 21, N.Y.
Izv. vŷsshikh uchebnŷkh zavedenii, Fizika (USSR)	Izvestiya vŷsshikh uchebnŷkh zavedenii, Fizika. Tomsk University, Tomsk.
J. fluid Mech. (GB)	Journal of Fluid Mechanics Cambridge University Press, Bentley House, Euston Road, London, N.W.1.
Jenaer Jahrbuch (Germany)	Jenaer Jahrbuch VEB Carl Zeiss Jena, Carl-Zeiss-Strasse 1, Jena.
Kumamoto J. Sci. (Japan)	Kumamoto Journal of Science. Series A (Mathematics, Physics and Chemistry) Faculty of Science, Kumamoto University, Kumamoto.
Mem. Defense Acad. (Japan)	Memoirs of the Defense Academy (Mathematics, Physics, Chemistry and Engineering) The Defense Academy, Yokosuka.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany)	Monatsberichte der Deutschen Akademie der Wissenschaften zu Berlin. Publishers: Akademie-Verlag, Mohrenstrasse 39, Berlin, W.8.
Res. Rep. Faculty Engng Meiji Univ. (Japan)	Research Reports of the Faculty of Engineering, Meiji University. Meiji.
Solid-State Electronics (GB)	Solid-State Electronics Pergamon Press, Headington Hill Hall, Oxford; 122 East 55th Street, New York 22, N.Y.
Stud. Cercetari stiint., Fiz. Stiint. tehn. (Roumania)	Studii şi Cercetări Ştiinţifice. Fizică şi Ştiinţe Tehnice. Academia Republicii Populare Romîne. Subscription address: Librăria Academiei R.P.R., Calea Victoriei 27, Bucarest.
Tokyo astron. Bull. (Japan)	Tokyo Astronomical Bulletin. Tokyo Astronomical Observatory, University of Tokyo, Mitaka, Tokyo.

NEW JOURNAL

Isotopentechnik (Germany)	Isotopentechnik VEB Deutscher Verlag für Grundstoffindustrie, Karl-Heine Str. 27, Leipzig W.31. Vol. 1, No. 1, dated August, 1960.

CHANGE OF TITLE

IRE Trans med. Electronics (USA)	IRE Transactions on Medical Electronics. Title changed to: IRE Transactions on Bio-Medical Electronics (IRE Trans bio-med. Electronics) with issue dated No. 1, Jan., 1961.

ERRATA

Abstr. 19632 (1960) line 3: for "A.V.Vorob'ev" read "A.A.Vorob'ev".
Abstr. 20778 (1960) line 3: for "A.A.Lipkin" read "A.A.Lipnik".
Author Index (Nov., 1960): for "Šupančič,C." read "Župančič,C.".
Author Index (Dec., 1960): after "Ginzburg,V.L." for "20703-4" read "20703, 20974".
Abstr. 440, 788, 979, 2374 (1961) journal reference: for "(1960)" read "(1961)".
Author Index (Jan., 1961). For correct alphabetical order of letter "K" read as follows:
Col. 3, line 14: Kadomtseva,A.M., 1239 to end of letter.
Col. 2, line 32: Kesseler,G., 409 to Col. 3, line 13, Kossler, H.J., 1261
Col. 3, line 51: Kotera,T., 70 to Col. 2, line 31, Kuznetzova,E.A., 1451
Author Index (Jan., 1961): for "Salin,R.A." read "Swalin,R.A."

AUTHOR INDEX

Abarenkov,I.V., 3663
Abragam,A., 2769
Abrosimov,A.T., 3280
Ackerman,M., 3573
Adirovich,E.I., 3584
Adrianova,I.I., 2879
Agdur,B., 2987
Ageeva,N.S., 2723
Agranovich,V.M., 3851
Ainslie,N.G., 3690-1
Aizu,H., 3316-17
Akabane,K., 2658
Akiyama,Y., 3399
Albert,R.D., 3447
Albini,F.A., 3057
Aleksandrov,K.S., 4059
Alekseevskii,N.E., 3726
Alers,G.A., 3955
Alexander,K.F., 3524
Alexander,S., 3570
Alfandari,R., 3062
Alikhanov,A.I., 3411
Alikhanov,R.A., 3919
Alikhanyan,A.T., 3279
Allcock,G.McK., 4114
Alston,M., 3240
Alvarez,L.W., 3240
Amati,D., 3241
Ambegaokar,V., 3617
Amelinckx,S., 3674
Amith,A., 3723
Amma,E.L., 4052
Amoignon,J., 2794
Amram,Y., 2931
Amsel,G., 3086
Amus'ya,M.Ya., 3391
Anastasiadis,É., 4021
Anders,E., 2607
Anderson,A.E., 3001
Anderson,H.R., 3342
Andrade e Silva,J., 2705
Andreev,V.V., 3614
Andresciani,V., 3794
Andrew,E.R., 3942
Androes,G.M., 2922
Andrussow,L., 2729
Ankudinov,E.P., 3400
Ansell,G.S., 3970
Antonov,R.A., 3284
Antropov,G.P., 3454
Apostolescu,S., 3481
Arajs,S., 3711
Arima,A., 3386
Arkhangel'skii,M.E., 4106
Armstrong,R., 3986
Arnold,W.H., Jr, 3191
Ashmore,A., 3185
Asimov,S.A., 3274
Askaryan,G., 3313
Askar'yan,G.A., 3053
Aslanian,J., 2917
Auberger,M., 2822
Ausländer,D., 3891
Authier,A., 3031
Auzins,P., 3653
Averbach,B.L., 3971
Avetikov,V.G., 3800
Axel,P., 3404
Axford,W.I., 2597
Azbel',M.Ya., 3643, 3649
Azimov,S.A., 3273

Babayan,C.P., 3271
Bachelet,F., 3344
Bacon,G.E., 3701
Baczynski,A., 2762
Bagge,E., 3353
Baicker,J.A., 2998
Baikov,I.S., 3423
Baird,J.C., 3536
Baker,J.G., 3536
Baker,S.C., 2936
Balabanov,E.I., 3728
Balarin,M., 3621
Balata,P., 3344
Balescu,R., 2961-2
Balk,P., 3589
Balkanski,M., 3619
Ball,J.S., 3176
Ballario,M.C., 2622
Bally,D., 3886
Ban,M.I., 3620
Bansal,T.D., 2740
Baradzey,L.T., 3291
Baranger,E., 3394
Barashenko,V.S., 3441
Barber,D.R., 2606
Barbier,D., 4131
Bardócz,A., 3511
Barkov,V.I., 2720
Barledzh,S., 2823
Barnett,M.P., 4098
Barrett,A.H., 2659
Barrett,E.B., 3067
Barriol,J., 3623, 3625
Barrow,B.B., 2932
Barrow,C.H., 2660
Bartholomeyczyk,W., 2880
Bartke,J., 3262
Bartlett,J.T., 3670
Barton,M.Q., 3028
Baruch,P., 3086
Barut,A.O., 3128, 3133
Bar'yakhtar,V.G., 3884, 3921
Bashkirov,Sh.Sh., 3927
Bashmakov,V.I., 4010
Batchelor,R., 3465
Batenin,I.V., 3698
Bates,C.W., Jr, 3780
Bates,D.R., 3516
Batsanov,S.S., 3818
Batty,C.J., 3210
Baum,R.L., 3816
Baumgardt,E., 4155
Bayhurst,B.P., 3452
Bazarov,I.P., 3611
Bazhulin,P.A., 2859
Beckurts,K.H., 2930
Beers,Y., 3074
Behrens,E., 3631
Beiser,A., 3048
Bekefi,G., 2959, 2978
Belford,R.L., 3561
Belikovich,B.A., 4025
Belikovich,B.A., 4025
Bell,E.G., 4140
Belonogov,A.V., 3097
Belous,Yu.V., 3719
Belov,K.P., 3719
Belov,N.V., 4057
Benczer-Koller,N., 3406
Bengus,V.Z., 3668
Benson,G.C., 3589
Berdyshev,A.A., 3917
Berg,H.F., 2782
Beringer,R., 3383
Berkelman,K., 3165
Berlin,A.A., 3728
Berlovich,E.E., 3405
Bernal,I., 3566
Bernheim,R.A., 3574
Betts,D.D., 3608
Bhagavantam,S., 3958
Bhatia,A.B., 3596
Bhattacharya,R., 3563
Bhattacharyya,B.K., 4137
Biberman,L.M., 2708
Biedenharn,L.C., 3402
Bienenstock,A., 4037
Bierlein,T.K., 3699-700
Biermann,L., 3332
Bigeleisen,J., 3581
Bilger,R.C., 4152
Billardon,M., 2756
Bilwes,R., 3458
Binder,O., 3353
Biot,M.A., 2818
Bird,G.R., 3536
Bird,J.R., 2935
Birger,N.G., 3267
Birss,R.R., 3907
Biswas,S., 3318
Bjorken,J.D., 3137
Blakemore,J.S., 3666
Blanc,D., 2945, 3022
Blank,A.A., 4153
Blankenship,J.L., 3085, 3250
Blässer,G., 3485
Blatt,F.J., 3710
Blatt,J.M., 2920
Bleaney,B., 3928
Blinov,G.A., 3098
Blinov,V.A., 3400
Blistanov,A.A., 3677
Blokh,Ya.L., 3337, 3345-7
Blomgren,E., 4105
Bloom,S.D., 3080
Bochkova,O.P., 2950
Bockris,J.O'M., 4105
Bodenseh,H.K., 3537
Bodmer,A.R., 3512
Böer,K.W., 3785
Boersch,H., 3017, 3822
Boggs,J.E., 3535
Bogolyubov,N.N., 2714
Bohm,D., 2696
Boischot,A., 2645, 2652
Boivin,G., 2882
Bokhan,N.A., 2605
Bolef,D.I., 3954
Boll,R., 3910
Bologa,M.K., 4001
Boltaks,B.I., 3688, 3756
Bonch-Bruevich,V.L., 3615
Bonjour,E., 2912
Bonnor,W.B., 2684
Boos,E.G., 3438
Borkowski,C.J., 3085, 3250
Borovskii,I.B., 4060
Bothorel,P., 3764
Boulloud,J.P., 2799
Bourelier,F., 4011-12
Bourret,R.C., 2709
Bowen,I.S., 2639
Boy,F., 3764
Boyarskaya,Yu.S., 4001
Boyle,A.J.F., 3604
Bozenberg,G.V., 4110
Bozorth,R.M., 3911
Braddock,J.V., 2765
Brainin,É.I., 3991
Bransden,B.H., 3249
Braun,E.A., 3582
Braun,M.A., 3107
Bray,P.J., 3935
Breit,G., 3138
Brenig,W., 3382
Breuer,G., 3448
Brice,J.C., 2913
Brilliantov,N.A., 3835
Brindley,J., 2731
Bristow,J.R., 3673
Brittain,J.O., 3963
Britton,D., 3565
Brockman,K.W., Jr, 3246
Brolley,J.E., Jr, 3440
Brooks,F.D., 3078
Broser,I., 3852
Brown,A., 2867
Brown,C.R., 4147
Brown,G.E., 3381
Brown,S.C., 2959, 2978
Brown,W.L., 3082, 3084
Broyles,A.A., 3500
Brunner,W., 3467
Bruzek,A., 2623
Bube,R.H., 3784
Buchert,H., 3537
Buckel,W., 3725
Buehler,E., 3037
Buinov,N.N., 4015
Buishvili,L.L., 3922
Bukovska,M., 4056
Bulatova,R.F., 4043
Bullough,K., 4132
Bumiller,F., 3178
Bunbury,D.S.P., 3604
Bund,G.W., 3228
Buralge,S.R., 2823
Buravleva,M.G., 4024
Burbank,R.D., 3579
Burge,R.E., 4090
Burgess,J.H., 3941
Burgess,R.E., 3737
Burke,P.G., 3171
Burke,V.M., 3509
Burkhardt,G., 2986
Burmistrov,V.R., 3419
Burnham,D.C., 4029
Burns,J., 3002
Bushbridge,I.W., 2634
Butra,F.P., 3703
Bychkov,Yu.A., 3705
Bystrikov,A.S., 3667

Cabé,J., 2945
Cadeville,M.C., 3889
Caffyn,J.E., 3694
Caglioti,V., 3523
Cahen,M., 2690
Cairó,L., 3064
Calvert,J.M., 3446
Calvert,N.M., 3460
Calvet,E., 2910
Cann,G.L., 2946
Cap,F., 3487
Capellaro,D.F., 2844
Carey,R., 3901
Carlson,B.C., 2713
Carmichael,A.J., 3965
Carmichael,H., 3363
Carome,E.F., 2823
Carreras-Patxot,R., 4109
Cashwell,E.D., 2585
Cassels,J.M., 3165
Castaing,R., 3020
Castillejo,L., 3381
Caswell,H.L., 2921
Catania,A.C., 4142
Catlin,A., 4009
Causse,J.P., 2996
Causse,R., 3044
Cernigoi,C., 2991
Chandrasekhar,B.S., 2923
Chantreau,J., 3013
Charakhchyan,A.N., 3324
Charakhchyan,T.N., 3324
Charles,R.J., 4072
Chase,R.L., 2938
Chasson,R.L., 3348
Cheishvili,O.D., 3922
Chelam,E.V., 3958-60
Chen Fan-Yun, 2650
Chentsov,R., 2916
Cherdyntsev,V.V., 3304
Cherkashin,M.I., 3728
Chernavsky,D.S., 3269, 3276
Chernikov,N.A., 3124
Chernov,A.A., 4023
Cherville,J., 3764
Chetaev,D.N., 2824
Chetham-Strode,A., 3254
Chibisov,K.V., 2895
Chikovani,G.E., 3303
Chilashvili,G.A., 3434
Childs,C.B., 3679
Chiplis,V.I., 3502
Chistovich,L.A., 4146
Chistyakov,Yu.D., 4045
Chiu,H.-Y., 2636
Chong Wan Lee, 3394
Chopra,K.P., 2668
Chou Kuang-chao, 3198, 3211
Chovin,P., 2910
Chrenko,R.M., 3657
Christiansen,W.H., 2786
Chudakov,A.E., 3282-3, 3309
Chynoweth,A.G., 3779
Chzhou Guan-chzao, 3198, 3211
Cindro,N., 3076
Ciok,P., 3262
Citron,A., 3369
Clampitt,B.H., 4107
Clancy,E.P., 2675
Clark,G., 3368
Clarke,F.J.P., 4014
Class,C.M., 3425
Clayton,G.T., 2745-6
Clinton,W., 3498
Clogston,A.M., 3882
Cloupeau,M., 2784
Clube,S.V.M., 2620
Cobble,J.W., 3473-4
Cocconi,G., 3185
Codelupi,R., 3040
Cofta,H., 3916
Coggeshall,N.D., 3571
Cohen,B.L., 3397-8, 3456
Cohen,M., 3551
Cohen,M.H., 2658, 4073
Colby,L.J., Jr, 3473-4
Coleman,R.V., 4030
Collins,C., 3069
Collins,W.E., 4163
Comsa,G., 2795
Conforto,A.M., 3344
Conkie,W.R., 3189

)nnor,R.D., 2992
)nrad,H., 3986
)nsoli,T., 2969
)ok,B.P., 4041
)ok,G.H., 2897
)pan,T.P., 4077
)penhaver,R.M., 4156
)pley,G.J., 3968
)ppel,W.A., 2774
)rbett,J.W., 3656-7
)rciovei,A., 3630
)renzwit,E., 3882
)rnille,H., 2703-4
)tton,F.A., 3831
)ulson,C.A., 3551
)urant,H., 3222
)urtney-Pratt,J.S., 2669
)vell,W.P., 4152
)vington,A.E., 2648
)x,J.P., 2630
)raik,D.J., 3898
)ranshaw,T.E., 3292
)roissiaux,M., 3178
)roll,I.M., 3875
)row,T.T., 3147
)ller,P., 2896
)lvahouse,J.W., 3586
)rl,R.F., Jr, 2536
)rry,C., 3514
)rtiss,C.F., 4098
)zajkowski,M., 2762
)zerwonko,J., 2711
)zyż,W., 3200

Dabbs,J.W.T., 3089
Daiyasu,K., 3229
Dalgarno,A., 3522
D'Angelo,N., 2981
Danielian,A., 3918, 3920
Daniels,J.M., 3585
da Providencia,J., 3376
Das,A., 2688
Das,M., 3563
Das,T.P., 3503, 3574
Dasgupta,P., 4125
Datsko,O.I., 3962
Daughtry,J.W , 3248
David,E.E., Jr, 4143
Davidge,R.W., 3678
Davidson,W., 2692
Davies,R.D., 2664-5
Davis,H., 4152
Davis,J., 2590
Davis,L., 3332
Davis,L., Jr, 3331
Day,T.B., 3232
Dayal,B., 3592
Dazey,M.H., 2976
Deam,A.P., 3535
de Andrés,M.P., 3714
Dearman,H.H., 3560
Deatherage,B.H., 4149
DeBeer,J.F., 3292
Debever,R., 2690
Debrunner,H., 3372
Degeilh,A., 3022
de Gennes,P.G., 3945
Dekhtyar,I.Ya., 3151
de Kowaslewski,D.G., 3567
Delavignette,P., 3674
Delbecq,C.J., 3840
Deloff,A., 3209
Delvaille,J., 3285, 3326
Delves,L.M., 3134
Demetriades,A., 2958
Demidenko,Z.A., 3741
Demidov,B.A., 3374
Dempsey,E., 3589
Dennery,P., 3127
de Oliveira,D.R., 3167
Derkacheva,L.D., 2764
Des Cloizeaux,J., 2701, 3619
De Shong,J.A., Jr, 3495
DeSorbo,W., 4068
Deubner,A., 3811
Devons,S., 3160
DeWitt,C.M., 2681
Dhuicq,D., 3015
Dickstein,S., 2725
Diddens,A.N., 3185
Dietrich,W., 3904
Dikii,L.A., 2734
DiMaggio,F.L., 3806
Dixon,J.A., 2747
Dmitriev,A.B., 4167
Dmitriev,V.A., 3280, 3287-8
Dmitriev,V.N., 3475
Dolginov,S.Sh., 3306
Dolique,J.M., 2970
Donnadieu,G.A., 2899
Donovan,B., 3826
Donovan,P.F., 3082, 3088
Doré,R., 3525
Dorman,L.I., 3333, 3338, 3343, 3345-7, 3358
Dovzenko,O.I., 3290
Dovzhenko,O.I., 3367
Dow,W.G., 3012
Downing,M., 3034
Doyle,P.H., 2965
Drachman,R.J., 2717
Drapchinskii,L.V., 3475
Dreizler,H., 3539
Drickamer,H.G., 3832-4
Drowart,J., 3573
Droz-Vincent,P., 2691
Dubinin,V.G., 3857-8
Dubinskaya,N., 3155
Dubrovin,M.M., 3271
Duchesne,M., 2591
Duclos,J., 2927
Dudkin,L.D., 3769
Duff,G.F.D., 2810
Duffey,G.H., 3564
Duffus,H.J., 4128
Duggal,S.P., 3351
Duke,P.J., 3314
Dunaeva,S.M., 4001
Duncan,A.B.F., 3548
Dunford,H.B., 4093
Dunn,B.J., 2765
Dunn,C.G., 3661
Durham,F.E., 3425
Duthie,J., 3257-8
Duthie,J.G., 3364-5
Dykhne,A.M., 3600
Dyring,E., 3373
Dzyub,I.P., 3389, 3747

East,L.V., 2828
Eberhard,P., 3240
Ebert,I., 3948
Ebhardt,R., 3745
Eckart,F., 3748
Ecker,G., 2964
Edwards,C., 3604
Edwards,P.L., 2798
Edwards,T.H., 2869
Éfrussi,M.M., 2804
Ehmert,A., 3334
Ehrlich,G., 4083, 4100-1
Eichenbaum,A.L., 3007
Eischens,R.P., 4102
Eisenstein,J.C., 3543
Elbaum,C., 3975
Eldred,K.McK., 2803
Eldredge,D.H., 4152
Eliseev,G.P., 3411
Elliot,H., 3357
Ellis,R.A., Jr, 2979
El'yashevich,M.A., 3555
Emberson,D.L., 3000
Emel'yanov,A.A., 3367
Engel,J.R., 3482
Engelke,C.E., 3077
Engler,H.D., 3092
Engstrom,R.W., 2993
Érastov,L.N., 2911, 3470
Ermolsev,V.L., 3576
Escobar,I., 3368
Esin,V.O., 4019
Essig,S.F., 2997
Éstrin,M.I., 3972
Evans,D., 3315
Evans,G.C., 2661
Evans,J.A., 3381
Evans,J.C., 2758
Evdokimov,V.D., 4003
Everett,C.J., 2585
Ewan,G.T., 3166
Eyring,E.M., 3575
Ezawa,H., 3170
Ezer,D., 2628

Fahl,C., 2986
Fahleson,U.V., 2980
Fairstein,E., 2937
Faissner,H., 3175
Fakidov,I.G., 3897
Fallon,R.J., 3529
Fan,H.Y., 3759
Fanchenko,S.A., 3374
Fanguin,R., 3061
Farbshtein,I.I., 3773
Farnell,G.W., 3602
Fatuzzo,E., 3807
Fedchenko,E.D., 3445
Fedchenko,K.K., 3356
Federbush,P., 3105
Fedin,E.I., 3072
Fedotov,I.I., 2673
Fedotov,P.I., 3099
Feibelman,W.A., 2621
Feldmann,W.L., 3779
Félici,N., 2767
Feltham,P., 3968
Feltin'sh,I., 3766
Fer,F., 2705
Ferguson,A.J., 3465
Fernandez,A., 3810
Fernando,P.C.B., 3388
Fields,T.H., 2583
Filiminov,V.N., 3544
Findley,R.W., 2583
Fine,M.E., 3660
Firor,J., 2644
Fischer,F.A., 2814
Fish,R.A., 2607
Fisher,C., 3258
Fisher,C.M., 3257, 3364-5
Fisher,J.C., 3731
Fisher,M.E., 3583
Fisk,H.E., 3244
Fleury,J., 2927
Folberth,O.G., 3760
Fomenko,L.A., 3912
Foreman,B.M., 3088
Forrester,P.A., 3055
Fortmann,J., 3725
Fotchenkov,A.A., 3806
Fouret,R., 2951
Fowler,E., 3222
Fowler,P., 3844
Fowler,P.H., 3257-8, 3301, 3364-5
Fowler,R.G., 2785
Fowler,W.A., 2638
Fox,L., 3551
Frank,R.C., 3685
Frankevich,E.L., 3728
Frankl',F.I., 2776
Fredricks,R.W., 2811
Freeman,A.J., 3629, 3639
Frei,K., 2868
Freise,E.J., 3660
Freon,A., 3355
Frerichs,R., 3765
Fretter,W.B., 3266
Frey,D.A., 3950
Fried,R.D., 2985
Friedel,J., 3945
Friedland,S.S., 3081
Friedländer,E.M., 3201
Frind,G., 2956
Frish,S.É., 3499
Frohlich,F., 2861
Frohlich,R., 3493
Fuji,Y., 3139
Fujii,K., 3214
Fujiki,Y., 4067
Fujimoto,Y., 3316-17
Fujita,E., 3642, 3646
Fukada,I., 3109
Fukuda,H., 3297
Fukushima,S., 3359
Fukutome,H., 3111
Funt,B.L., 3078
Furui,S., 3233
Furuichi,S., 3139
Fyfe,W.I., 2783

Gabrielli,I., 2991
Gaidukov,P., 3726
Gale,B., 4088
Gale,N.H., 3460
Galkin,A.A., 3598
Gall,B., 3312
Galperin,G.I., 3311
Gal'pern,D.Yu., 2848
Galun,R., 2725
Garber,R.I., 3990
Garg,J.B., 3460
Garibyan,G.M., 3158
Gashimzade,F.M., 3622
Gasström,R.V., 2934
Gavrishchak,I.V., 3708
Geballe,T.H., 3753
Gedeonov,L.I., 3400
Geguzin,Ya.E., 3979, 4024 4075
Geick,R., 3817
Gélard,J., 2939
Geldmacher,R.C., 2941
Geller,R., 2969
Gemesy,T., 3286
Gendrin,R., 3068
Generalov,N.A., 2778
Gérardin,C., 3458
Gerhart,J.B., 3415
Gerholm,T.R., 3421
Gerjuoy,E., 2972
Germer,L.H., 4085
Gerold,V., 3651
Gershuni,G.V., 4144
Gershuni,G.Z., 3599
Ghildyal,C.D., 2738
Ghosh,T.K., 4014
Giaever,I., 3731
Gibbons,P.E., 3154
Gibson,W.M., 3088
Gierula,J., 3262
Giese,R.H., 2609
Giffels,C.A., 3588
Gilbert,E.G., 2586
Gilbert,J.F., 3757
Gilde,F.J., 3620
Giles,J.C., 3585
Gill,A.M.R., 4141
Gill,P.S., 3453
Gill,S.J., 3034
Gilvarry,J.J., 2599-601
Gindin,I.A., 3990
Ging,J.L., 2681
Ginzburg,V.L., 2982, 3159
Giorgi,T.A.G., 4103
Giovanelli,R.G., 2655
Girgis,R.K., 3412
Girifalco,L.A., 3692
Giron,G., 2945
Glashow,S.L., 3200
Glauberman,A.E., 3733
Glaume,J., 4131
Glazkov,V.I., 3569
Gliki,N.V., 4020
Glodeanu,A., 3886
Glokova,E.S., 3336, 3346, 3354
Godoli,G., 2616
Gogosov,V.V., 3046
Goldanskii,V.I., 3227
Goldberg,J., 3008
Gol'dman,A.G., 3870
Goldsworthy,G.A., 2596
Goles,G.G., 2607
Goncharova,V.A., 3957
Good,M.L., 3240
Goodings,D.A., 3628
Goodman,C.H.L., 3782
Gorban',I.S., 3830, 3838
Gordon,E.I., 3009
Gordon,R.D., 3546
Gordy,W., 3937
Gorman,J.G., 2979
Gorshkov,V.G., 3422
Gorski,W., 2796, 3987
Goryunov,N.N., 3280, 3287-8
Gould,R.W., 2985, 3011
Gove,H.E., 3465
Grabowski,Z., 3418
Graf,K., 2727
Grainger,R.J., 3090
Grashin,A.F., 3169
Graziano,W., 3240
Grecu,D., 3630
Greenberg,J.M., 2594-5, 2887
Greene,D., 3027
Greene,D.C., 2805
Greene,R.F., 3742
Greger,G., 4028
Greifinger,P.S., 2983
Greiner,J.H., 3875
Greisen,K., 3285, 3326, 3375
Gridnev,V.N., 4064
Griem,H.R., 2782
Griffiths,J.H.E., 3653
Griffy,T.A., 3402
Grigor'ev,V.I., 3145
Grigorov,N.L., 3265, 3271
Grimes,H.H., 3692
Grimmeiss,H.G., 3786, 3861
Grinberg,A.A., 3776
Grohmann,K., 3017
Groschwitz,E., 3745
Grosjean,M., 2894
Gross,B., 3809
Gross,E.F., 3829, 3842
Grossweiner,L.I., 3893
Groth,R., 3861
Grum-Grzhimailo,S.V., 3835
Grzedzielski,S., 2641
Gubkin,A.N., 3802
Guillemard,R., 2951
Guillon,H., 2931
Gulbransen,E.A., 4077
Gunkel,R.D., 4156

Günthard,H.H., 2868
Gurevich,A.V., 2982
Gurevich,M.M., 2866
Gurov,K.P., 4060
Gutowsky,H.S., 3952
Gusev,A.A., 3915
Gustafsson,S., 3418
Guzhavin,V.I., 3298
Gvaladze,Yu.S., 2974
Gyulai,J., 3734

Haasen,P., 3735
Haddock,F.T., 2653
Häfele,H.G., 3847
Häfele,W., 3492
Hage,W., 3195
Hahn,D., 3869
Hain,G., 2973
Hain,K., 2973
Haisty,R.W., 2926
Haken,H., 3635
Hale,K.F., 4088
Hall,D.J., 3205
Hall,F.R., 3775
Hall,H.E., 3604
Hall,J.J., 3754
Häller,I.B., 3418
Ham,G.S., 3934
Hama,F.R., 2739
Hamada,T., 3172
Hamburger,E.W., 3456
Hamilton,R.A.H., 3249
Hamisch,H., 3017
Haneman,D., 4078
Hans,H.S., 3453
Hansen,L.F., 3266, 3447
Hansen,R.S., 4107
Hara,Y., 3174
Haraldson,S., 3033
Hardy,J.R., 3799
Hardy,R., 2873
Harrap,V., 3772
Harris,G.M., 3952
Harris,L., 3813, 3844
Harrison,L.G., 4076
Harrison,S.E., 3566
Hartman,C.D., 4085
Hartman,P.L., 2871, 3814
Hartmann,P., 3003
Hartwig,G., 3417
Harvey,J.S.M., 3932
Hasegawa,S., 3316-17
Hashimoto,H., 4089
Haskin,D.M., 3256, 3322
Hasnain,S.A., 3483
Hatt,B.A., 4062
Hattori,A., 2671
Haubert,A., 4118
Hawkins,T.D.H., 3790
Haworth,C.W., 4042
Hayakawa,S., 3296, 3328-9, 3429
Hayashi,C., 3328
Hayes,W., 3840
Hays,E.E., 2820
Hazard,C., 2667
Head,A.K., 3664
Hearne,J.A., 3094
Heaton,LeR., 2745-6
Hecht,K., 3486
Heeschen,D.S., 2666
Heiland,G., 3738
Heine,V., 3628
Heise,R., 3811
Helbig,E., 3795
Hellwarth,R.W., 3859
Hély,J., 2687
Hendus,H., 4074
Henisch,H.K., 3871
Henry,W.G., 3949
Hensley,E.B., 2988-9
Hermstein,W., 2957
Hernqvist,K.G., 3007
Hersil,J., 3368
Hervé,J., 3071
Herz,A.J., 3307
Heusinkveld,W.A., 2906
Hexter,R.M., 3591
Higashi,S., 3294
Higgins,J., 2712
Higinbotham,W.A., 2938
Hiida,K., 3177, 3179
Hijikata,K., 3556-7
Hildebrand,B., 3320
Hill,D.W., 4140
Hillig,W.B., 4072
Hillion,P., 2696
Hillmann,B., 4155
Hilsum,C., 3715, 3768
Hines,R.L., 3026
Hinman,G.W., 3588
Hinterregger,H.E., 2598
Hiroike,K., 2716, 2749
Hirschfelder,J.O., 4095, 4098
Hirshfield,J.L., 2959
Hirth,J.P., 4022
Ho Tso-Hsiu, 3211
Hoarau,J., 3879
Hodgson,P.E., 3444
Hoffman,R.E., 3690
Hoffmann,K.W., 3410
Hofmeister,E., 3745
Hofstadter,R., 3178
Hoge,H.J., 2908
Holdaway,H.W., 3965
Holden,J., 3984
Holladay,W.G., 3147
Holscher,P.C., 3065
Hołynski,R., 3262
Hondros,E.D., 4013
Hone,D., 2918
Hoodless,I.M., 4076
Hook,J.R., 4140
Hopfield,J.J., 3636
Hopkins,J.C., 3415
Hopkins,R.E., 2851
Hori,J., 3593
Hornbogen,E., 4070
Hornig,D.F., 3843
Horstmann,M., 3018
Horton,G.K., 3609
Houtermans,F.G., 3372
Howarth,C.I., 4157
Howe,S., 3975
Hoyle,F., 2638
Hsu,F.S.L., 3037
Hsüeh Shih-yin, 3688
Hu Ren-Chao, 4113
Huang Su-Shu, 2637
Huber,W.K., 2793
Huch,W.F., 2589
Huffington,J.D., 3961
Huffstutler,M.C., Jr, 4091
Huggins,R.A., 3899
Hughes,H.G., 2785
Hughes,V.W., 3202
Hughes,W.F., 2735
Hugot,C., 2931
Hugus,Z.Z., Jr, 3565
Hull,M.H., 3138
Humason,M.L., 2642
Hume-Rothery,W., 4061
Hummel,R.W., 3094
Hurle,D.T.J., 3713
Hurley,J., 3047
Hurst,R.P., 3603
Hurvich,L.M., 4161
Hurwitz,H., Jr, 3051
Husain,M.K., 2992
Huzinaga,S., 3519
Hynds,R.J., 3357

Iakovlev,V.I., 3290
Ibuki,S., 3684
Ichikawa,Y.H., 2968, 3156
Ida,M., 3136
Iernetti,G., 2991
Igi,K., 3197
Ignatius,A., 3065
Ihara,C., 3215
Ikeda,K., 2914
Ikeda,M., 3119
Ikhasanova,V., 2649
Il'ina,V.A., 3698
Ilyukhin,V.V., 4057
Imamura,T., 3206
Indenbom,V.L., 4033
Infeld,L., 2689
Ingarden,R.S., 2584
Inman,D., 4105
Inoki,M., 3225
Inozemtseva,O.I., 3346, 3354
Ionescu-Pallas,N.I., 3533
Irkhin,Y.P., 3706
Irving,B.A., 4079
Irving,E., 4138
Isaac,E.D., 3898
Isakovich,M A., 2807
Ishida,K., 3212
Ishii,K., 3985
Ismailzade,I G., 4053
Ito,D., 3173, 3214
Ito,K., 3328
Itoh,N., 3792
Ivanenko,I.P., 3298-9, 3309
Ivanenko,V.M., 3304
Ivanov-Shits,K.M., 2817
Ivanovskii,V.I., 3896
Iveronova,V.I., 4066
Ivlev,D.D., 3977
Iwadare,J., 3172
Iwamoto,F., 3144
Izui,K., 3672
Izuyama,T., 3883

Jabłonski,A., 2760
Jackson,H.G., 2936
Jackson,R.W., 3251-2
Jacob,G., 3439
Jacobsohn,B.A., 3231
Jahn,R.G., 3057
Jahr,R., 3455
Jain,P.L., 3322
James,E., Jr, 4099
Jameson,D., 4161
Jancovici,B., 3380
Jeener,J., 3073
Jeffrey,G.A., 4052
Jellinghaus,W., 3714
Jelly,D.H., 3069
Jennings,L.D., 2925, 3605
Jennison,R.C., 2664-5
Johansson,A., 3444
Johns,J.W.C., 3572
Johnson,A.A., 3993
Johnson,C.C., 3011
Johnston,H.M., 2662
Johnston,T.L., 3996
Johnston,W.G., 3999
Jones,D., 2802
Jones,D.P., 3223
Jones,F.C., 3153
Jones,G.D., 3846
Jones,L.W., 3101
Jones,O.C., 2836
Jones,R.H., 3771
Jones,R.V., 2854
Jönsson,C., 3016
Josephson,V., 2976
Joshi,S.K., 3597
Jugaku,J., 3328
Jungk,G., 3748

Kachinskii,V.N., 3717
Kadashevich,Yu.I., 3976
Kaddoura,A., 3257-8, 3364-5
Kaempffer,F.A., 3117
Kagan,Yu., 3755
Kaganov,M.I., 3633
Kahan,T., 3064
Kahn,A.H., 2707
Kaidanovskii,N.L., 2643
Kaifer,R.C., 3080
Kaiser,W., 3662
Kalashnikov,S.G., 3750
Kalashnikova,V.I., 3477
Kalinin,V.A., 3610
Kallistratova,M.A., 2827
Kalra,S.N., 2726
Kalyush,A.V., 3594
Kamei,O., 3170
Kaminer,N.S., 3339, 3345, 3347
Kamper,R.A., 3932
Kanazawa,H., 3645-7, 3876
Kandaurova,G.S., 3903
Kane,W.M., 3772
Kanev,S., 3762
Kanevskii,I.N., 2815
Kanter,H., 3005-6
Kapany,N.S., 2844-6
Kaplan,R., 3935
Kaplyanskii,A.A., 3829
Karczewski,B., 3059-60
Kard,P.G., 2875-6
Karimov,R., 3274
Karp,A., 4159
Karpenko,B.V., 3917
Karplus,M., 3562, 3568
Kartashev,A.I., 2847
Kashkarov,L.L., 3304
Katayama,Y., 3164, 3167
Katsnel'son,A.A., 4066
Katz,L., 3435
Katz,S., 2967
Kautz,B.R., 2805
Kawaguchi,M., 3207
Kawarabayashi,K., 3217-18
Keating,K.B., 3832, 3834
Keldȳsh,L.V., 3749
Keller,J.B., 3590
Keller,J.M., 2713
Kellet,E.A., 4041
Kelly,A., 3660
Keloglu,Yu.P., 4001
Kendziorski,F., 3285 3326
Kennedy,A.J., 4000
Kenney,J.F., 3349
Kerimov,B.K., 3114
Kerker,M., 2889-90
Kern,W., 3401
Kerns,Q., 3778
Kérom,E., 2823
Kervalidze,K.N., 2974
Kessel',A.R., 3387
Keyes,R.W., 3930
Khachaturyan,A.G., 4039
Khaikin,A.S., 3812
Khaikin,S.E., 2643
Khaldin,N.N., 3194
Khalkin,V.A., 3461
Khastgir,S.R., 4124
Khavin,L.S., 3274
Khé Tszo-Syu, 3211
Khernov,B.A., 3293
Khodakov,A.L., 3808
Khotkevich,V.I., 3654
Khrenov,B.A., 3280
Khristiansen,G.B., 3280, 3283, 3287-8, 3293
Khrshanovskii,S.A., 2870
Khutsishvili,G.R., 3922, 3944
Kiessling,R., 3480
Kikoin,I.K., 3718
Kikuchi,M., 3974
Kilb,R.W., 3051
Kim,Y.W., 3935
King,G.W., 3546
King,J.M., 3535
King,R.W., 3161
Kinsey,J.L., 3536
Kitao,K., 3042
Klaboe,P., 3540
Klaus,H., 3795
Kleinheinz,P., 3413
Kleinman,D.A., 3845
Klemen'tev,V.N., 3405
Kleppa,O.J., 2750
Klimontovich,Yu.L., 2963
Klucharev,A.P., 3445
Kluckow,R., 2948
Klyushnikov,V.D., 3978
Kmetko,E.A., 3989
Knight,W.D., 2922
Knoll,M.E., 4165
Knox,W.A., 2588
Knox,W.J., 3383
Koba,Z., 3429
Kobayakawa,K., 3206
Kobayasi,M., 3384
Kobzarev,I.Yu., 3230
Koch,L., 3253, 3778
Kochelaev,B.I., 3943
Kodama,M., 3359
Koelmans,H., 3786
Koenig,S.H., 3754
Kogan,V.S., 4043
Kohler,R.H., 3515
Kokorish,Yu.E., 4026
Kolganov,V.Z., 3096-7
Kolobkov,V.P., 3866
Kolontsova,E.V., 3702
Kołos,W., 3518
Kolpakov,M.I., 3099
Kolyadin,K.I., 2866
Komar,A.P., 3436
Komatsuzawa,A., 3239
Komel'kov,V.S., 2975
Kommandeur,J., 3775, 3938
Kondo,J., 3936
Kondrashev,L.F., 3194
Kondratiev,N.A., 3265
Konenkov,Yu.K., 2808
König,H., 4115
Konobeevskii,S.T., 3703
Konorov,P.P., 3770
Kontorovich,I.E., 3683
Kopaleishvili,T.I., 3434
Köppendörfer,W., 2973
Kopȳlov,G.I., 3149
Korneeva,I.V., 4006
Korolyuk,A.P., 3598
Kosevich,A.M., 3614, 4010
Koshiba,M., 3316-17, 3329
Koshkin,N.I., 2825
Kotik,J., 2853
Kotlarevsky,D.M., 3303
Kottenstette,J.P., 4096
Koutecký,J., 3632
Kovrizhnikh,A.A., 3454

walewski,V.J., 3567
zlov,A.A., 3303
all,N.A., 2984
anzer,H.C., 2960
asnov,L.B., 3405
asnovskii,A.A., 3872
asovskii,V.P., 3897
assovsky,V.I., 3311
atenko,Yu.P., 3274
aut,A., 3466
auze,W., 2796-7
avstov,N.V., 3036
aybill,H., 3222
ebs,J.J., 3953
echko,M.S., 3527
ipyakevich,P.I., 4032, 4040
ishnan,K.S., 2904
istiansson,K., 3323
itskaya,V.K., 3698
ivko,N.I., 3638
ivoglaz,M.A., 4038
oll,N.M., 3127
onmüller,H., 3659
öplin,P., 2864
oupa,F., 3669
ucheanu,E., 4045
uschwitz,W.H., 2674
utov,V.A., 3422
zhemenek,Ya., 3436
ıckes,A.F., 3182
ıdashev,E.F., 3304
ıdielka,H., 3030
ıdryashov,P.I., 2761, 2763
ıiper,J.W., 2657
ıkharskii,A.A., 3687
ıks,I.M., 3260
ılikov,G.V., 3280, 3283, 3287-8
ılikov,G.S., 3756
ındu,M.R., 2657
ınzler,J.E., 3037
ırashov,A.A., 3194
ırdyumov,G.V., 3698
ırita,Y., 3937
ırova,I.A., 3751
ızmin,A.I., 3340, 3352
ız'min,R.N., 4049
ız'min,V.N., 3099
ıznetsov,V.V., 3461
ıznetsova,M.Ya., 3461
vartskhava,I.F., 2974

ábušča,E., 3914
agarde,A., 3821
ai,K., 3101
allemand,A., 2591
ande,K., 3102
andesman,A., 2769
andsberg,L.G., 3097
andsman,A.P., 3687
ane,H.L., 4142
anger,D., 4166
anger,J.S., 3617
ansrauz,G., 2882
a Paglia,S.R., 3548
aPaz,L., 2670
apina,A.V., 2879
apointe,S.M., 3371
arenz,R.W., 2986
askar,W., 3171
assettre,E.N., 3559
assila,K.E., 3138
atimer,P., 2757
au,E., 2850
aukonis,J.V., 4030
aurie,V.W., 3538
avakare,P.J., 3318
avrent'ev,F.F., 3668
Lawless,K.R., 4009
Lawson,J., 3508
Lawson,W., 3508
Lazarev,B.G., 4043
Lazarev,S.D., 3718
Lazareva,T.P., 3259
Lbov,A.A., 3454
Lea,K.R., 3932
Leal Ferreira,J., 3164
Leal Ferreira,P., 3228
Lebedev,A.V., 3096-7
Lebedev,B.P., 4094
Lebedev,V.I., 3477
Lebedev,V.S., 2779
Lebedinsky,A.I., 3309
Le Bihan,M.T., 4050
LeBlanc,M.A.R., 3585
Ledoux,P., 2633
Lee,E.W., 3907
Lee,M.A., 3781
Lee,R.W., 3685
Lee Chong Wan, 3394
Lefebvre,R., 3560, 3939
Legardeur,R., 2969
Leger,E.G., 2727
Legrand,J.P., 3350
Legrand,M., 2894
Le Héricy,J., 4012
Leibfried,G., 3601
Leipunskii,O.I., 4117
Lempicki,A., 2867
Lenel,F.V., 3970
Lenior,M., 2682
Lenk,A., 2722
Lenz,K., 2860
Leray,J., 2893
Lerfald,G., 3070
Lerner,M.M., 3730
Le Roux,É., 3058
Leroy,J.L., 2615
Leruste,P., 2705
Leslie,P.R.R., 2663
Leutwyler,H., 2694
Levelt,J.M.H., 3603
Leven-Fisher,N.P., 4167
Levi,M.W., 3586
Lévy,A., 2838
Lévy,M., 3186
Lewandowski,Z., 3100
Lewis,H.W., 3449
Lewis,R.M., 3590
Lewis,T.J., 2954
Li,C.H., 3996
Li,J.C.M., 3665
Li Sen-Dzhun., 4081
Li Seng-jung, 4081
Liberman,I., 3765
Liehr,A.D., 3554
Lifshitz,I.M., 3633
Lifshitz,J., 3312
Liller,W., 2604
Limareva,L.A., 2763
Lin,S.C., 2783
Linden,B.R., 2995
Lindenfeld,P., 2909
Lindgren,S., 3373
Lindt,W., 3372
Linvev,A.F., 3194
Lippmann,B.A., 3520
Litherland,A.E., 3465
Littler,D.J., 3469
Litvin,F.F., 3872
Livingston;R., 3655
Lobov,G.A., 3424
Lochak,G., 2705
Lockwood,G.E.K., 2672
Logan,R.A., 3757, 3779
Logunov,A.A., 3124
Lohrmann,E., 3256, 3322
Lomanov,M.F., 3098
Longsworth,L.G., 2752
Lorquet,J.C., 3549
Losev,S.A., 2778
Losievskaya,S.A., 4049
Love,T.A., 3193
Low,W., 3933
Lozhkin,O.V., 3468
Lubchenko,A.F., 3389
Luckey,G.W., 3727
Ludwig,G.W., 3934
Ludwig,W., 3601
Lukirskii,A.P., 3029
Lukirskii,A.P., 2990, 3029
Lundin,A.G., 4059
Lunev,V.V., 2773
Lun'kin,Yu.P., 2772, 2777
Lur'e,K.A., 3043
Lutskii,A.E., 2755
L'vov,S.N., 3707
Lyon,A.J., 4127
Lyskovich,A.B., 4025
Lyubimov,V.A., 3411

Maak,J., 3861
Maas,R.W., 2589
McCaldin,J.O., 3752
McCauley,G.P., 3103
McChesney,M., 2953
McClure,J.W., 3880
McDonald,D.F., 2765
MacDonald,D.K., 3796
McDonald,R.S., 3657
Macek,J.H., 3564
McGrath,J.W., 3931, 4055
Machida,M., 3225
McIlwain,C., 3305
Mack,D.A., 2936
Mackenzie,J.M., 3083, 3166
Mackintosh,I.M., 3082
McLaren,K.G., 4004
McLellan,A.G., 3497
MacMahon,J.P., 2933
McMillan,J.A., 3881
McMillen,J.H., 2676
McMorrow,E.W., 2829
McNarry,L.R., 2617
McNeill,D.J., 3514
McNeill,P.C., 2953
McNiven,H.D., 2809
McSkimin,H.J., 2819
Madansky,L., 3459
Maddock,A.J., 4164
Madigan,J.R., 2902
Madikyan,R.A., 4024
Maeda,H., 4134
Maeda,K., 3348
Magnac-Valette,D., 3458
Maier,G., 3637
Maitland,R., 2932
Majumdar,K., 3841
Maki,Z., 3120, 3237
Makover,S.G., 2605
Makowska-Rzeszutko,M., 3100
Maksimenko,V.M., 3150, 3227
Málek,Z., 3894-5
Malitson,H.H., 2612
Malkovich,R.Sh., 3680, 3756
Malkus,W.V.R., 2943
Malone,C.P., 3034
Malov,N.N., 2673
Mal'tsev,A.A., 3545
Malykh,V.D., 2955
Malyuzhinets,G.D., 2881
Mamasakhlisov,V.I., 3434
Manassi,V., 2907
Mani,G.S., 3450
Manjavidze,Z.Sh., 3303
Mann,A.K., 3102
Manning,J.J., 2999
Marathe,B.R., 3871
Marchand,A., 3763-4
Marcley,R.G., 3038, 3187
Marini,G., 3344
Maris,T.A.J., 3439
Märkl,H., 3490
Marklund,I., 3418
Markov,M.N., 3812
Markstein,G.H., 2781
Marlotte,G., 2958
Marn,D., 3095
Marsh,D.M., 3995
Marumori,T., 3384
Marx,G., 4054
Mase,S., 3722
Mashkovets,M.D., 3800
Mastel,B., 3699-700
Matheson,R.M., 2993
Mathews,M.V., 4143
Mathieson,O., 3323
Mathur,V.S., 3501
Matijević,E., 2889-90
Matsomoto,M., 3247
Matsudaira,N., 3647, 3876
Matsumae,S., 3906
Matsumoto,M., 3245
Matsuo,S., 3180
Matthes,W., 3484
Matthews,A.G., 3069
Matthews,J.J., 2953
Matthews,P.M., 2699
Matthias,B.T., 3037, 3882
Matumoto,K., 3121
Matumoto,Z., 3408
Maxim,I., 3891-2
May,R.M., 3877
Mayer,J.W., 3081, 3090
Mayo,S., 3397-8
Mazalov,L.N., 3818
Mazo,R.M., 3510
Meadows,J.W., Jr, 3471
Medvedev,B.V., 3142
Meisser,O., 4108
Meizner,J., 3056
Mekhedov,V.N., 3461
Meltzer,A.S., 2594
Men',A.N., 4051
Mendelson,E.S., 4150
Meredith,J.E., 4018
Mermel'shtein,Yu.M., 3683
Merrill,R.C., 3814
Mertsching,J., 3704
Merzabekian,E.G., 2650
Meshkovskii,A.G., 3098
Messier,J., 3253, 3778
Metenin,V.I., 2775
Metz,A., 2839
Metzger,J., 3625
Meyer,A.J.P., 3889
Meyer,G., 3018
Meyers,M.D., 3831
Michel,A.E., 3793
Middelhoek,S., 3900
Middleton,W.E.K., 4162
Mięsowicz,M., 3262
Mikaelyan,L.A., 3414
Mikhailov,G.M., 4059
Mikhalenkov,V.S., 3151
Milekhin,G.A., 3275, 3277
Millar,R.F., 2885-6
Miller,G.L., 2938, 3082, 3088
Miller,J.E., 4143
Miller,M.H., 3012
Miller,R.E., 3605
Miller,R.L., 3843
Milmoe,J.O., 4096
Milner,S.R., 2679-80
Milton,E.R.V., 4093
Mims,W.B., 3055
Minakov,V.N., 4064
Minami,S., 3188, 3216, 3219, 3234
Mingazin,T.A., 4044
Minn,S., 3712
Minturn,R.E., 4107
Mirion,I., 3914
Misawa,S., 3646
Mishakova,A.P., 3261
Mishchenko,L.S., 3271
Misra,S.P., 2697
Mitani,S., 3294
Mitchell,G.E., 3449
Mitchell,J.W., 3670
Mito,I., 3316-17
Mitra,S.N., 4125
Mitropol'skaya,O.N., 4136
Mitsek,A.I., 3908
Miyakawa,T., 3823
Miyamoto,K., 2840, 2843
Miyatake,Y., 3108, 3123
Miyazaki,Y., 3308
Miyazawa,H., 3174, 3217
Möbius,H.E., 3893
Moffat,J.W., 3220
Mohan,H., 3841
Molchanov,A.P., 2650
Møller,A.R., 4151
Möller,H., 3030
Montilla,J., 3820
Montuelle,J., 4011-12
Mooney,R.W., 2865
Moore,A.J.W., 4013
Moore,C.E., 2612
Moore,M.S., 3425
Moore,R.A., 3596
Morduch,G.E., 2683
Moreau,J., 2794
Moreton,G.E., 2656
Morgan,P.G., 2736
Mori,K., 3170
Moriamez,C., 2768
Morita,T., 2748-9
Moroz,L.G., 3141
Moroz,N.G., 4010
Morozov,A.I., 3750
Morrison,G.C., 3463
Morrison,J.A., 3010, 4076
Morrison,P., 2636
Morrow,C.T., 2812
Moser,F., 4029
Moskalenko,S.A., 3827
Moss,T.S., 3790
Moureu,H., 2910
Mukherjee,A., 3503
Müller,A., 3488-9
Müller,K.D., 3455
Müller,R., 2618
Müller-Hillebrand,D., 4112
Münch,G., 2593
Munro,G.H., 4121
Mura,T., 3963
Murayama,T., 3325
Murgai,M.P., 4096
Murphy,P.G., 3223
Murphy,P.V., 3809
Murray,R.B., 2999, 3193
Murray,R.L., 3483
Murthy,G.T., 3327
Murty,Y.S.N., 4124
Murzin,V.S., 3271
Murzina,E.A., 3290
Musa,G., 2795
Muschlitz,E.E., Jr, 3521
Muss,D.R., 3695

Myers,A., 3595
Myrgren,B., 3033

Nagae,M., 3823
Nagashima,T., 3887
Nakagawa,M., 3120-1
Nakajima,S., 3724
Nakanishi,N., 3143, 3177, 3179
Nakau,T., 3924
Namba,S., 3825
Namiki,M., 3430
Namioka,T., 2883-4
Narasimhaiah,H., 3428
Narbut,T.P., 4024
Nariai,H., 2592
Narumi,H., 3180
Nasledov,D.N., 3777
Nauenberg,M., 3137
Naumkina,N.I., 2804
Naya,S., 3885
Nechin,Yu.A., 3280, 3287-8
Neelakantan,K.A., 3318
Neff,H., 3967
Neher,H.V., 3075, 3342
Nelson,R.R., 2747
Nemchenko,V.F., 3707
Neporent,B.S., 3534
Neshpor,V.S., 3709, 3716
Nesterova,N.M., 3282-3
Nettel,S.J., 3634
Nettleton,R.E., 2903
Neuert,H., 3448
Neufeld,E.L., 4123
Neufeld,J., 2965
Neumann,M.J., 3002
Newkirk,G.,Jr, 2647
Newman,R.C., 4087
Newsome,R., 3101
Newstein,M.C., 2853
Ney,E.P., 2589
Nguyen-Huu-Doan, 4130
Nichimura,J., 3316
Niekisch,E.A., 3761
Nielsen,J.R., 3540
Nielsen,O.B., 3426
Niese,H., 2834
Nigam,A.N., 3513, 3848
Nigam,B.P., 3181
Nikishov,A.I., 3203, 3268
Nikitin,E.N., 3797
Nikitin,M.K., 3405
Nikitin,S.Ya., 3096-7
Nikitin,Yu.P., 3169
Nikolsky,B.A., 3261
Nikolsky,S.I., 3283, 3289-90
Nishida,M., 2626, 3328
Nishimura,J., 3317
Niu,K., 3278
Nix,W.D., 3899
Nocilla,S., 2770
Nomura,K.C., 3666
Norbeck,E., 3462
Northrop,D.C., 3154
Nosanow,L.H., 2919
Noskova,L.M., 3917
Novozhilov,V.V., 3976
Nozdrev,V.F., 2825
Nutant,J., 2739
Nyberg,D., 2727

Obayashi,T., 4119
Oberlin,M., 3764
Obinyakov,B.A., 3427
O'Dell,F.W., 3320-1
Ogawa,S., 3119
Ogilvie,K.W., 3307, 3407
Ogimoto,T., 3115
Ogita,N., 3297
Ohnuki,Y., 3119-20, 3130
Ohta,T., 3823
Ohtsuka,T., 3888
Ohyama,N., 3328
Okamoto,T., 3720-1
Oke,J.B., 2629
Okoniewski,S., 4071
Okun',L.B., 3226, 3230
Olbert,S., 3368
Olive,G., 3021
Oliver,J.W., 3090
Olley,J., 3307
Olmos,L.F., 3997
Olson,D.N., 3165
Oneda,S., 3238
O'Neill,P.L., 3223
Ôno,Y., 2780
Öpik,E.J., 2602
Orbach,R., 3613
Oria,M., 2791
Origlio,S., 4103
Orlova,N.P., 2673
Orr,R.L., 4063
Ortenberg,F.S., 3550, 3553
Orton,J.W., 3653
Oshio,T., 3294
Oster,L., 3157
Osterbrock,D.E., 2640
Osterle,J.F., 2735
Oswald,W., 3455
Otsuki,S., 3172
Ottewill,R.H., 2889
Owen,G.E., 3459
Ozaki,S., 3129, 3375
Özemre,A.Y., 3190, 3491

Pacault,A., 3763-4
Pachner,J., 2693
Pafomov,V.E., 3152
Pagel,B.E.J., 2619
Pak,W., 3375
Palik,E.D., 2855, 3819
Palumbo,D.T., 2865
Panichi,U., 3618
Panova,A.N., 2755
Pantchev,S., 2737
Paoletti,A., 2751
Papapetrou,A., 2686
Parfen'ev,P.V., 3773
Parham,A.G., 3292
Parini,V.P., 3728
Parker,E.N., 2611
Parker,K., 3444
Parker,W.E., 2828
Parks,J.R., 4092
Parsons,J.L., 3542
Parsons,N.R., 3370
Pashinkim,A.S., 4006
Pati,J.C., 3238
Pauchard,R., 3062
Paul,H., 3420, 3467
Pavlov,V.A., 3962
Pavlovskaya,É.A., 4017
Paxton,G.W., 2785
Pazienza,G., 2826,2830
Peacock,T.E., 3624
Pearson,R.F., 3925
Pearson,W.B., 3736, 3796
Pedersen,J.C., 2887
Pedersen,N.E., 2887
Peek,J.M., 3559
Peletminskii,S.V., 3921
Perfilov,N.A., 3468
Perkins,D.H., 3257-8, 3301, 3364-5
Perkins,M., 3361
Perl,M.L., 3101
Perls,T.A., 2813
Pernegr,J., 3264
Pervakov,V.A., 3654
Pescia,J., 3071
Peter,M., 3882
Peterkop,R., 3116
Peterlin,A., 2730
Peters,B., 3327
Peterson,S.W., 4046
Petiau,J., 4050
Petrash,G.G., 2874
Petrov,T.G., 4027
Petrzhak,K.A., 3475
Petržílka,V., 3264
Pettersson,B.G., 3421
Pfeifer,H., 2928
Philipp,H.R., 3815
Phillips,G.C., 3396, 3402
Phillips,J.C., 3640
Phillips,V.A., 3691
Picht,J., 2702
Pierre,J., 2800
Pikel'ner,S.B., 4133
Pillet,G., 4120
Pines,B.Ya., 3992
Pinkau,K., 3257-8, 3301, 3364-5
Pinsker,Z.G., 4081
Pinus,G.N., 4106
Pipkin,A.C., 2790
Pivovarov,V.M., 2759
Platt,J.R., 2677
Plyavin',I.K., 3865
Podgoretskii,M.I., 3392
Podgurskaya,A.V., 3265
Pohlit,H., 3196
Pohlit,W., 3196
Poincelot,P., 3041
Poirier,Y., 3044
Pokrovskii,V.L., 3600, 4016
Poll,J.D., 2789
Pondrom,L.G., 3248
Pool,M.L., 3428
Popov,N.M., 4036
Popov,Yu.V., 2879, 3853
Porai-Koshits,M.A., 4056
Porte,A.L., 3952
Postma,H., 3183
Potapkov,N.A., 3874
Potter,R.J., 2851
Pound,G.M., 4022
Predvoditelev,A.A., 3667, 4017
Prepost,R., 3202
Preston,B.W., 4160
Prestwood,R.J., 3452
Price,P.B., 3669
Price,P.J., 3930
Price,R.E., 3397-8, 3456
Prikhot'ko,A.F., 3850
Prima,A.M., 3828
Pringle,R.W., 3078
Prokhorov,A.M., 3940
Prokhorov,Yu.G., 2977
Prokof'ev,A.N., 3451
Provisor,H., 3686
Prowse,D.J., 3244
Ptitsyn,O.B., 3578
Purcell,J.D., 2612
Püschel,W., 3242
Pushkov,N.V., 3306
Pustovalov,G.E., 3527
Putley,E.H., 3791
Puttick,K.E., 3994
Pytkowski,S., 2797
Pytte,A., 2971

Quenby,J.J., 3357

Raab,A., 3048
Raab,D.H., 4148
Radchenko,V.P., 3419
Radojičič,D., 3221
Ragusa,S., 3167
Raguzin,R.M., 3099
Raikhbaum,Ya.D., 2955
Rakin,V.G., 4015
Rama Murthy,V., 2608
Ramanamurthy,P.V., 3327
Ramanathan,K.G., 3606
Ramavataram,K., 3460
Ramsay,D.A., 3572
Randall,J.E., 4139
Rao,C.N.R., 4047
Rao,D.A.A.S.N., 3450
Rao,U.R., 3351
Raoult,G., 3061
Rapoport,I.D., 3271
Rapp,R.A., 4022
Rashba,É.I., 3740, 3850
Rasmussen,J.O., 3587
Ratcliffe,J.A., 4126
Ratinskaya,A., 2816
Ratner,S.B., 4002
Rau,J., 2699
Ray,R.K., 3759
Rayne,J.A., 2923
Razbirin,B.S., 3842
Razdan,H., 3351
Razumovskaya,L.P., 2950
Read,F.H., 3446
Rebane,T.K., 3558
Redfield,D., 3816
Rees,B.L., 3673
Regel',V.R., 4016
Regener,V.H., 3349
Reibel,K., 3102
Reich,A.D., 2902
Reichardt,W., 2722
Reimann,H., 2862, 3487
Reinov,N.M., 3638
Rester,D.H., 3425
Reuter,B., 4054
Rez,I.S., 4031
Rezanov,A.I., 3616
Ricci,R.A., 3412
Ridley,B.K., 3694
Ridley,R.G., 3023
Riech,V., 3448
Riemann,M., 2863
Rienitz,J., 2850
Rieu,M., 2801
Rigden,J.D., 3839
Rinehart,J.S., 2822
Risler,J.C., 2873
Riviere,A.C., 2947
Roaf,D.J., 4061
Roberts,J.A., 2654-7, 4062
Roberts,K.V., 2973
Roberts,L.D., 3089
Roberts,M.W., 4080
Roberts,P.H., 2710
Roberts,R.W., 3941
Roberts,S.J., 2973
Robinson,B.J., 4122
Rochester,G.K., 3388
Rodberg,L.S., 3433
Roe,B.P., 3375
Roesmer,J., 3471
Roinishvili,N.N., 3303
Roizen,I.I., 3392
Romano,G., 2635
Romanov,Yu.A., 3648
Romanov,Yu.F., 3475
Romanyuk,N.A., 3805
Romashkin,Yu., 3689
Romashkin,Yu.P., 3980-3
Rombakh,V.P., 3836
Ronchi,V., 2835
Röppischer,H., 3863
Rosa,R.J., 3052
Rose,D.C., 3363, 3371
Rosen,L., 3440
Rosenbaum,J.H., 2818
Rosenberg,B., 3787
Rosenberg,H.M., 3612
Rosenberg,L., 2706
Rosenbluth,M.N., 2972 2984
Rosendahl,R., 2842
Rosenfield,A.R., 3971
Rosenthal,I.L., 3268
Rossi,B., 3281
Rostovskii,V.S., 3416
Roth,S.J., 2994
Rothe,O., 2928
Rothwell,P., 3305
Roy,J.C., 3472
Roy,P.K., 3235
Rozenberg,G.V., 2858
Rozenberg,N.Yu., 3800
Rozenshtein,L.D., 3783
Rozenthal',I.L., 3150
Rozhin,F.V., 2817
Rozin,L.A., 2771
Rubenstein,H., 4147
Rubins,R.S., 3928
Rubtsov,V.I., 3291
Rudd,De F.P., 2754
Rudik,A.P., 3226
Rudnick,P., 2721
Rudolph,H.D., 3539
Ruei,K.H., 3133
Rule,E., 2813
Rumanova,I.M., 4034
Rumsh,M.A., 2990, 3029
Runciman,W.A., 3846
Ruppel,H.M., 3138
Rushbrooke,J.G., 3221
Rusjan,B., 2898
Russell,B., 3988
Rutherglen,J.G., 3208
Ryasanov,M.I., 3199
Ryndin,R.M., 3231
Rynn,N., 2981
Ryzhenko,B.N., 4006

Safarov,V.I., 3842
Saganenko,A.A., 3866
Saito,M., 3974
Sakamoto,Y., 3184, 3442-3
Sakashita,S., 2780
Sakata,S., 3120
Sakharov,V.N., 4117
Sakita,B., 3238
Sakuma,T., 3213, 3233
Sakurai,J.J., 3126
Salam,A., 3125
Sălceanu,C., 2821
Salesse,M., 3479
Salomonovich,A.E., 2650
Samelson,H., 2867
Samogyi,A., 3335
Samoilova,I.K., 4145
Samsonov,G.V., 3707, 3709, 3716
Sanborn,R.H., 3541
Sanders,C.L., 2836
Sandor,T., 3286, 3335
Sandström,A.E., 3360, 337
Sandweiss,J., 3222
Sänger,R., 4109
Saniewwaka,T., 3262
Santirocco,R.A., 4116
Sapozhnikov,R.A., 2905
Sapp,R.C., 3586
Sarabhai,V., 3351
Saraceno,A.J., 3571
Sarojini,V., 2766
Sarrak,V.I., 3998
Sarycheva,L.I., 3271
Sasakawa,T., 3377, 3437

try,T.S.G., 3351
lnier,A., 4069
el'eva,A.I., 3265
vada,S., 3146
vada,T., 3218
vkill,J., 4018
o,S., 3113
z,H.G., 3710
rf,E.L., 3066
alge,R., 2841
eibe,P., 3070
eibling,G., 2893
ein,M., 3256, 3316-17, 3322
enkel,F.W., 2995
ey,H.M., 3520
iller,P., 3659
lömann,E., 3909
malberger,D.C., 2627
midt,F.H., 3415
midt-Rohr,U., 3455
mitt,R., 2896
muntzsch,M., 2861
nell,G., 4074
oeck,G., 3986
olz,A., 3681
ön,M., 3867
ooley,J.F., 3587
rader,C.D., 3080
röder,R., 3482
ultz,J.W., 3666
umacher,B.W., 2724
üppel,W., 3894-5
warzschild,M., 2633
weitzer,J., 2792, 2799
wuttke,G.H., 3652
tt,D., 3368
aton,M.J., 3506-9
cker,P.E., 2954
eger,A., 3659, 3735
gel,L.A., 2732
hgal,M.L., 3453
iden,J., 3890
ifert,G., 3947-8
livanenko,A.S., 3853
livanenko,N.E., 2673
mel,M., 2614
min,G.K., 3072
ntyurina,L.V., 3032
ptier,A., 3014
ra,T.Ya., 3837
rdobolsky,V.I., 3431
rdyuk,V.V., 3837
rgeeva,V.M., 4065
th,K.K., 3449
well,G.L., 3732
ybolt,A.U., 3690
zerlénd,G., 2856
affer,J.D., 2831
alamov,Ya.Ya., 3098
alȳt,S.S., 3773
amov,V.P., 3468
apiro,M.M., 3320-1
arn,C.F., 3697
arov,B.V., 3698
arpe,J., 3079
askol'skaya,M.P., 3677
atilov,A.V., 2888
ebanov,V.A., 3098
eftal',N.N., 4026
eline,R.K., 3378
eridan,K.V., 2651
erwin,C.W., 2685
erwood,R.C., 3882
ewmon,P., 3682
estopalov,L.M., 3689, 3980
estoperov,V.Ya., 3265
ibata,H., 3294
imazu,H., 3106
Shimoida,H., 3170
Shiozaki,T., 3177, 3179
Shirley,D.A., 3587
Shirokov,M.I., 3432
Shirokov,V.I., 2761
Shivrin,O.N., 4086
Shklovsky,I.S., 3311, 3330
Shneider,A.D., 3708
Shoaf,M.L., 3474
Shpol'skii,É.V., 2857, 3860
Shpunt,A.A., 4024
Shreekanthan,B.V., 3327
Shtol'ts,E.V., 3903
Shukla,P.G., 3318
Shukla,R.C., 3531
Shuler,K.E., 3496
Shumaker,J.B., Jr, 2872, 2924
Shur,Ya.S., 3902-3, 3905
Shuravlev,N.N., 4049
Shuvalov,L.A., 3803-4
Shvedov,V.P., 3400
Sidorov,N.K., 2891
Sidorov,V.A., 3194
Siegbahn,K., 3421
Silberg,P.A., 4111
Silbiger,A., 3806
Silcock,J.M., 3969
Silin,V.P., 2963
Silva,R.J., 3254
Silver,D.E.P., 3023
Silverman,L.E., 3693
Silvester,N.R., 4090
Silvidi,A.A., 3095, 3931, 4055
Simák,V., 3264
Simha,R., 2753
Simms,P.C., 3406
Simon,P., 2645
Singer,J.R., 4158
Singer,L.S., 3938
Singer,S.F., 2602, 2692, 3310
Singh,S.P., 3592
Sirenko,A.F., 3992
Sirota,N.N., 3675
Sirotin,Yu.I., 4007
Sitenko,A.G., 3457
Sitnikov,K.P., 3929
Skinner,N.J., 4127
Skirda,N.V., 3260
Sklyarevskii,V.V., 3427
Skudrzyk,E.J., 2805
Skvortsov,Yu.V., 2975
Slavatinsky,S.A., 3267-9
Slavin,W., 2865
Slifkin,L., 3679
Slodzian,G., 3020
Slonim,I.Ya., 2892
Smirnov,K.A., 2990
Smirnov,L.A., 3029
Smirnov,V.A., 4044
Smirnova,N.N., 3777
Smith,F.L., 4096
Smith,G.A., 3222
Smith,G.M., 3521
Smith,H.G., 4046
Smith,K.F., 3388
Smith,L.C., 4099
Smits,F.M., 3739
Smolyankin,V.T., 3096-7
Smorodin,Yu.A., 3267, 3284, 3291
Smorodinskii,Ya., 3409
Smorodinskii,Ya.A., 3132
Smulkowski,O., 3086
Snell,P.A., 2995
Snitzer,E., 2852
Sobel'man,I.I., 3517
Sobiniakov,V.A., 3271
Sobinyakov,V.A., 3265
Soden,R.R., 3854
Sodha,M.S., 3163
Soifer,L.M., 3668
Sokolov,A.N., 3770
Sokolov,A.P., 3097
Sokolov,N.I., 3194
Sokolov,S.N., 2911, 3470
Sokolov,S.P., 3280
Sokolov,V.A., 3856
Solonitzin,Yu., 4082
Solov'ev,V.G., 3104
Soloviev,K.I., 3280
Soloviev,M V., 3291
Solovieva,V.I., 3280, 3283, 3287
Somogyi,A., 3286
Soo,J.P., 3263
Sorokin,P.P., 3873
Sotskov,B.S., 3032
Spedding,F.H., 3605
Spence,H.R., 2812
Spencer,C.L., 2656-7
Spencer,R.R., 3396
Spiegel,E.A., 2632-3
Spiro,I.J., 2849
Spitzer,W.G., 3845
Spivak,P.E., 3414
Springer,T., 3192
Spruch,L., 2706
Srinivasan,T.M., 3606-07
Srivastava,B.N., 3366
Srivastava,K.S., 3513
Srinivasan,T.M., 3606-7
Stachowiak,H., 2942
Stafford,F.E., 3573
Stan,V., 3891
Stanghellini,A., 3241
Stankowski,J., 3801
Starodubtsev,S.V., 3451
Startsev,V.I., 3668, 4024
Startseva,I.E., 3902
Stasiw,O., 3658
Stasyuk,I.V., 3733
Stearns,C.A., 3973
Stefant,R., 4135
Steljes,J.F., 3363
Stepanov,E.P., 3427
Stepanova,V.M., 4016
Stevens,K.W.H., 3918, 3920
Stevens,S.S., 4142
Stevenson,J.R., 2988
Stevenson,M.J., 3873
Stevenson,R., 3035
Steward,E.G., 4041
Stewart,C.E., 3163
Stewart,L., 3440
Stiller,B., 3320-1
Stockhausen,R.E., 2640
Stodiek,W., 2979
Stokes,R.J., 3996
Stott,P.M., 4138
Strakhovski,G.M., 3036
Strauss,A.J., 3767
Strokan,N.B., 3776
Stroth,J.E., 3415
Strugalsky,Z.S., 3280, 3287
Strunz,H., 4058
Strutinskii,V.M., 3476
Stuetzer,O.M., 2940
Stühmer,S., 3024
Subashiev,V.K., 3687
Sudarshan,E.C.G., 2699
Suellentrop,F.J., 2813
Sugano,R., 3229, 3239
Sugawara,T., 3951
Sugihara,T.T., 3471
Suita,T., 3792
Sujak,B., 3612
Sukhanova,O.N., 3835
Sulich,M., 3875
Sunyar,A.W., 3404
Surduts,A., 3788-9
Suri,A.N., 3366
Surin,A., 2695
Sushchinskii,M.M., 2859
Sutherland,G.B.B.M., 2856
Sutton,G.W., 3051
Sveshnikov,B.Ya., 2761, 2763
Svetlitsky,E.M., 3311
Svetozobov,I.A., 3300
Svirdova,R.K., 3835
Svirina,E.P., 3719
Swan,P., 3135
Swanson,K.M., 3942
Sweetman,D.R., 2947
Swets,D.E., 3685
Świt,A., 3758
Syozi,I., 3885
Syué Shi-in', 3688
Szaniawski,A., 2784

Tabor,D., 4004
Tachiki,M., 3913
Tachoire,H., 2910
Taft,E.A., 3815
Taft,H., 3222
Takabayasi,T., 2696, 3122
Takagi,S., 3429
Takahashi,A., 3212
Takaki,R., 3361
Takao,Y., 3130
Takemiya,T., 3184, 3443
Takemoto,S., 3923
Taketani,M., 3167
Takeuchi,H., 3308
Tal'roze,V.L., 3728
Tamagaki,R., 3172
Tamura,I., 3963
Tanabe,H., 4129
Tang,C.L., 3056
Tang,Y.C., 3395
Tani,S., 3878
Taniguchi,I., 3580
Tansley,K., 4156
Tanuma,S., 3722
Tardif,L., 2727
Tareev,B.M., 3730
Tarrant,J.R., 3254
Tartakovskii,B.D., 2804
Tatalashvili,N.G., 3303
Tatsumoto,E., 3720-1
Tavkhelidze,A.N., 3124
Taylor,H.S., 2962, 3478
Taylor,P.F., 3798
Tcherednitchenko,V., 2610
Teale,R.W., 3925
Teicher,M., 3322
Teitler,S., 3819
Telbisz,F., 3335
Teltow,J., 3658
Templeton,I.M., 3796
Tenney,H.D., 3941
Teodorescu,I., 3914
Terasawa,T., 3385-6
Terashima,Y., 3329, 3362
Terenin,A., 4082
Terenin,A.N., 3576
Ter-Martirosyan,K.A., 3110
Teucher,M.W., 3256
Teutsch,H., 3481
Thenard,J., 2931
Thomas,D.G., 3636
Thomas,G., 4091
Thomas,K., 4080
Thomas,W.J., 4084
Thompson,D.O., 3955
Thormann,E., 3448
Thorness,R.B., 2589
Thorson,I.M., 3435
Thouless,D.J., 3379, 3393
Thrower,E.N., 3956
Thun,J., 3421
Thurmond,C.D., 3662
Thurn,H., 4074
Tibell,G., 3444
Ticho,H.K., 3240
Tickner,A.W., 2952
Tietge,J., 3390
Tikhomirov,V.G., 4094
Timis,P., 3481
Timofeev,V.B., 3830
Timofeev,V.G., 3838
Timofeeva,V.A., 4020
Timofeyev,G.A., 3299
Timushev,G.F., 3093
Tinaut,D., 3820
Tippins,H.H., 4029
Tishchenko,G.B., 4006
Tkachuk,A.M., 3855
Tkalich,V.S., 3049
Tobias,I., 3529
Todorov,I.T., 3124
Tohmatsu,T., 4129
Tolkachov,B.V., 3291
Tollenaar,D., 2728
Tolokonnikov,L.A., 3966
Tolpȳgo,K.B., 3741
Tolstoi,N.A., 3849, 3855-6
Tolstov,K.D., 3441
Tombrello,T.A., 3450
Tonoyan,A.A., 3675
Tooper,R.F., 3163
Toth,K.S., 3426, 3464
Tousey,R., 2612
Townsend,J.R., 3695
Toyozawa,Y., 3743-4
Trapeznikova,Z.A., 3857-8
Treder,H., 2686
Trefilov,V.I., 4064
Treibus,E.B., 4027
Trendelenburg,E.A., 2793
Trent,G.H., 2651
Tretjakova,M.I., 3263
Trivelpiece,A.W., 3065
Troesch,B.A., 2812
Trorey,A.W., 2929
Trosnikov,I.V., 2715
Troup,G.J., 3054
Trumbore,F.A., 3757
Trykozko,R., 3774
Tsarenkov,B.V., 3777
Tserevitinov,S.S., 2975
Tsintsabadze,A.I., 3303
Tsushima,I., 3225
Tukish,E.I., 3282, 3289
Tulinova,Z.I., 3284
Tulupov,V.I., 3293
Turnbull,D., 3691, 4073
Turner,L.A., 2915
Turner,T.E., 3050
Turov,E.A., 3908
Turrell,G.C., 3532
Turski,A., 3063
Tuzzolino,A., 3361
Tyablikov,S.V., 3874
Tyapkina,N.D., 3751
Tyapunina,N.A., 3667, 4017

Überall,H., 3528
Ueda,A., 3297
Ueda,Y., 3212
Ueno,S., 2719
Ueno,Y., 2592
Ulmanis,U., 3155
Umezawa,H., 3130

Urizar,M.J., 4099
Ursell,H.D., 2710
Urushadze,G.I., 3884, 3926
Usik,P.A., 3259
Usui,T., 3641-2

Vacek,K., 3864
Vaidanich,V.I., 3769
Vainshtein,B.K., 4035
Vainshtein,L.A., 3517
Vaisenberg,O.A., 3204
Vali,V., 3050
Valiev,K.A., 3946
Valin,J., 3253
Van Shu-Fen., 3341
Van Yun-Yui, 3461
van Acker,J., 3014
Vandekerkhove,E., 2587
Vanderslice,J.T., 3529
Vander Velde,J.C., 3091, 3224
Vanetsian,R.A., 3445
Van Kranendonk,J., 2789
van Lieshout,R., 3412
van Oers,W.T.H., 3246
van Putten,J.D., 3091, 3224
Van Uitert,L.G., 3854
Vanyek,U.M., 3511
Vardya,M.S., 2625
Varfolomeyev,A.A., 3300
Varney,R.N., 2944
Varshni,Y.P., 3531
Vartanyan,A.T., 3783
Vashakidze,I.Sh., 3434
Vašíček,A., 2877
Vasil'chenko,L.S., 3032
Vasil'ev,V.I., 2975
Vasudevan,R., 2919
Vauquois,B., 2646
Vauthier,R., 3013
Vavilov,B.T., 3145
Vavilov,V.S., 3746
Veklenko,B.A., 2708
Velasco,R., 3547
Velyukhov,G.E., 3451
Venkates,H.G., 2733
Verdier,J., 2912
Vereshchagin,L.F., 3729, 3957
Verma,G.S., 3597 3964
Vernotte,P., 2900
Vernov,S.N., 3280, 3287-8, 3293, 3309
Veronis,G., 2943
Vicentini,M., 2751
Vigier,J.P., 2696
Vignes,A., 2741-4
Vij,K.K., 4125
Viktorova,E.N., 3866
Villena,L., 3820
Vishnevsky,V.F., 3272
Vitale,B., 3241
Vitol,I.K., 3865
Vizbaraite,Ya.I., 3502
Vladimirov,V.S., 2718
Vladimirov,Yu.A., 3872
Vlokh,O.G., 3824
Vol'kenshtein,M.V., 3577
Volkonskaya,T.G., 3299
von Roos,O., 3644
Voronov,F.F., 3957
Voros,T., 3511
Vosko,S.H., 3588
Vrkljan,V.S., 2787
Vul,B.M., 3749

Waddington,C.J., 3319, 3341
Wahl,C., 3037
Wahl,F., 3671
Wahrhaftig,A.L., 3575
Wakita,H., 2698
Waldeskog,B., 3323
Walker,J.C.G., 2603
Walker,J.K., 3208
Walker,M.F., 2591
Walker,W.P., 4009
Wallace,J.D., 2829
Wallace,L., 3530
Wallase,C.S., 3302
Wallor,R., 3026
Walsh,D., 2667
Walter,F.J., 3089
Walter,J.L., 3661
Wan Lee Chong, 3394
Wang Shou-Kuang, 2650
Wang Yung-Yu, 3461
Wantosch,H., 3785
Ward,J.C., 3125
Ward,M.A., 4138
Warschauer,D.M., 4166
Watabe,M., 3645
Watanabe,H., 3650, 4089
Watanabe,K., 3294
Watari,W., 3172
Watase,Y., 3294
Waters,J.R., 2935
Watkins,G.D., 3647, 3656, 3934
Watson,R.E., 3629
Watts-Tobin,R.J., 4104
Waugh,J.B.S., 3083
Weaver,H.E., 3950
Webb,P.P., 3087, 3251, 3252
Webb,W., 2747
Weekley,B., 3000
Wegner,H.E., 3255
Weil,L., 2917
Weill,J., 3494
Weintroub,S., 3713
Weiss,R.J., 3639
Weiss-Hollerwöger,B., 4005
Wells,F.H., 2935
Wendel,G., 3862-3
Wendt,H.D., 3413
Wendt,K., 2833
Wenk,G.J., 3357
Wentzel,D.G., 2631
Wenz,G.M., 2832
Wenzel,K., 3811
Wertz,J.E., 3653
Westheimer,G., 2878
Wetherell,A.M., 3185
White,C.T., 4154
White,D.H., 3102
White,D.R., 2788
White,R.B., 3307
Whitmer,R.F., 3067
Whitrow,G.J., 2683
Whitworth,R.W., 3678
Widom,B., 2754
Wiedersich,H., 3986
Wiese,W., 2782
Wiggins,J.S., 3081
Wilcock,W.L., 3000
Wild,J.P., 2651
Wildermuth,K., 3378, 3395
Wilenzick,R.M., 3449
Willax,H.A., 3025
Williams,B.R., 3942
Williams,H.J., 3882
Williams,R.L., 3087, 3251, 3252
Wilson,B.G., 3363
Wilson,D.V., 3988
Wilson,R., 3182-3
Wilson,R.R., 3165
Winkler,H., 3863
Winnewisser,M., 3537
Winogradzki,J., 2700
Wittry,D.B., 3752
Wohlleben,D., 3017
Woisard,E.L., 2901
Wojcicki,S.G., 3240
Wojciechowski,J., 3868
Wolf,K., 4074
Wolfenstein,L., 3236
Wolff,G.A., 3736
Wolter,H., 2837
Wolter,W., 3365
Wong,D.Y., 3176
Wood,C., 3772, 3798
Wood,W.W., 4097
Woodbury,H.H., 3934
Wooler,P.T., 3045
Woolons,D.J., 4141
Wormald,J.R., 3223
Wróbel,Z., 3100
Wrzecionko,J., 3209
Wu,C.S., 3406
Wuerker,R.F., 2976
Wybourne,B.G., 3504
Wyszechi,G.W., 4162

Yada,B., 2671
Yakovlev,R.M., 3260
Yakovlev,V.A., 3594
Yakubov,I.T., 3552
Yamaguchi,Y., 3118, 3162
Yamamoto,H., 3168
Yamamoto,K., 3115, 3140
Yamamoto,M., 3156, 4134
Yamashita,H., 3684
Yamazaki,H., 2780
Yasaki,T., 3225
Yavor,I.P., 3436
Yemelyanov,A.A., 3276
Yilmaz,F., 2613
Yoganarasimhan,S.R., 4047
Yokley,C.R., 2924
Yokoi,K., 3316-17
Yoneyama,T., 3170
Yonezawa,M., 3146
Yoshihara,H., 2966
Yoshimura,T., 3112, 3131
Yoshioka,H., 4048
Youffrey,B., 3020
Young,C.W., 2656
Young,F.W., Jr, 3676
Young,T.E., 3396
Yuan,L.C.L., 3088
Yuldashbaev,T.S., 3273
Yuldashev,A.A., 3274
Yurasova,V.E., 4017
Yurkov,B Ya , 3696
Yursik,I., 3405
Yuster,P.H., 3840
Yustis,A.P., 3502

Zăgănescu,M., 2821
Zahner,J.C., 3833
Zaidel',A.N., 3526
Zaidel',R.M., 2779
Zaikova,V.A., 3905
Zakin,J.L., 2753
Zaks,R.B., 3917
Zalivchii,V.N., 2825
Zanchetta,J., 3764
Zandberg,É.Ya., 3019
Zaslavskii,A.I., 4065
Zatsepin,G.T., 3290, 3295
Zatsepin,V.I., 3282
Zavaritskaya,É.I., 3749
Zdanis,R., 3459
Zeil,W., 3537
Zeldes,H., 3655
Zel'dovich,A.G., 3097
Zel'dovich,Ya.B., 3148, 3403
Zeleny,W.B., 3128
Zharkov,V.N., 3610
Zhdanov,A.P., 3099, 3260
Zhdanov,G.B., 3263
Zheenbaev,Zh., 2949
Zheludev,I.S., 3805, 3824, 4008
Zhestovskaya,M.I., 3702
Zhmyreva,I.A., 3866
Zhuravlev,N.N., 4044
Ziman,J.M., 3626-7
Zimerman,A.H., 3243
Zin,G., 3039
Ziock,K., 3202
Zirin,H., 2593
Zisin,Iu.A., 3454
Zlatkis,A.S., 3800
Zmuidzinas,J.S., 3644
Zubova,E.V., 3729
Zucker,I.J., 3583
Zverev,G.M., 3940
Zviagin,B.B., 4036
Zwanzig,R., 3496
Zwanziger,D.E., 3505
Zwicky,F., 2642

1960–1961

mmittee of Management

E INSTITUTION OF ELECTRICAL ENGINEERS
The President (*ex officio*)
L. Hartshorn, D.Sc., M.I.E.E.
R. W. Sillars, B.A., D.Phil., M.I.E.E.
R. L. Smith-Rose, C.B.E., D.Sc., Ph.D., M.I.E.E.
H. G. Taylor, D.Sc.(Eng.), M.I.E.E.

E INSTITUTE OF PHYSICS AND
E PHYSICAL SOCIETY
J. H. Awbery, M.A., B.Sc. (*Chairman*)
W. R. S. Garton, B.Sc.
D. Roaf, M.A., D.Phil.
Miss A. C. Stickland, M.Sc., Ph.D.
L. R. G. Treloar, B.Sc., Ph.D., D.Sc., F.Inst.P.

E ROYAL SOCIETY
W. C. Price, Sc.D., F.R.S.

E CENTRAL ELECTRICITY GENERATING BOARD
H. W. Gatehouse, A.M.I.E.E.

SERVER FOR THE AMERICAN PHYSICAL SOCIETY
T. H. Osgood, Ph.D.

litorial

ITOR
B. M. Crowther, M.A., Ph.D., F.Inst.P.

CTION EDITOR (Physics)
H. Jenkins, B.Sc., A.Inst.P.

CTION EDITOR (Electrical Engineering)
L. MacQuisten Wallace, B.Sc., A.M.I.E.E., A.M.I.E.(Aust.)

SISTANT EDITORS (Physics)
J. R. Day, B.Sc.
N. R. Fowler, A.R.C.S., D.I.C., F.Inst.P.
A. M. Lever, M.A.
A. Tybulewicz, B.Sc.
T. B. Wright, B.Sc., A.R.C.S.

SSISTANT EDITOR (Electrical Engineering)
J. J. Mulroy, B.Sc.

nnual Subscriptions

ience Abstracts is published in two sections, available separately:

Section A, *Physics Abstracts*	£10 0 0
Section B, *Electrical Engineering Abstracts*	£7 0 0
Both sections	£16 0 0

HE INSTITUTION OF ELECTRICAL ENGINEERS,
ivoy Place, London, W.C.2 *Telephone:* Covent Garden 1871

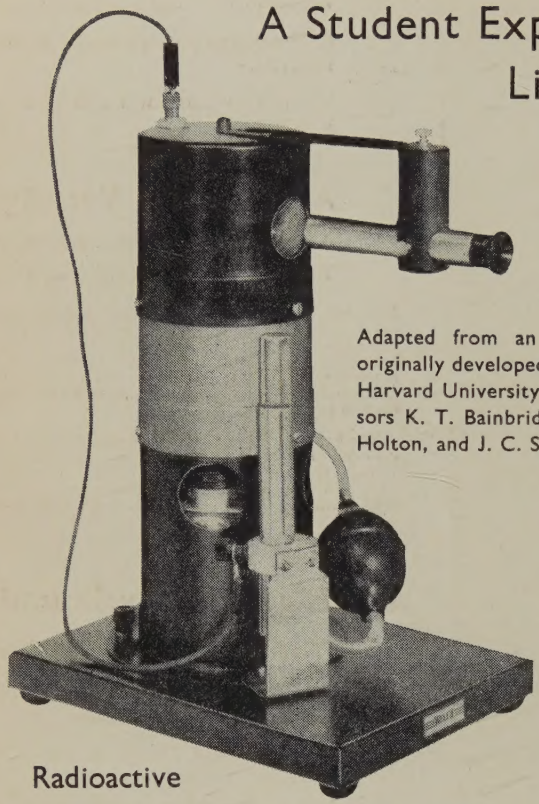
Completely safe

Welch

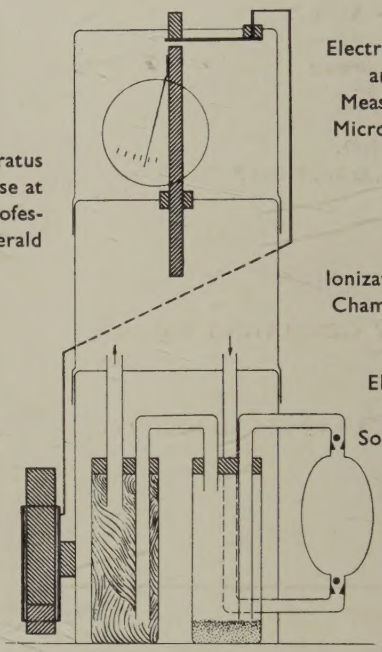
Simple to understand operate and maintain

Emanation Electroscope

A Student Experiment for Measuring the Half Life of Thoron (Rn^{220})



Adapted from an apparatus originally developed for use at Harvard University by Professors K. T. Bainbridge, Gerald Holton, and J. C. Street



Radioactive source included

No. 619

Student plots radioactive decay curve and computes half life to within two seconds

The Emanation Electroscope is intended for use by students at the introductory level in physics or chemistry for measuring the half life of a radioactive material with complete safety and without requiring costly or complicated electronic equipment.

The merit of this particular apparatus is that it is so simple to understand, to operate, and to maintain. The radioactive material (thorium oxide) is included, one filling is adequate for years of use, and it never needs to be removed from the apparatus. It causes no contamination problem because it has low activity and is circulated in a system normally closed to the atmosphere.

The apparatus is approximately 14 inches high and is mounted on a 7 × 10 inch wooden base. The three chambers may be slipped apart for inspection of contents. The upper one contains two plastic windows for illuminating and viewing the leaf without admitting air currents. The unit may be stored without disassembly or other special attention and is ready for use at all times.

No. 619. Each, $60.00

Recommended Accessories

STOP WATCH, 1/5 second. **No. 823A. Each, $17.75**

ELECTRIC STOP CLOCK. **No. 824L. Each, $37.50**

THE WELCH SCIENTIFIC COMPANY

ESTABLISHED 1880

1515 Sedgwick Street, Dept. PA Chicago 10, Illinois U.S.A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

PRINTED BY UNWIN BROTHERS LIMITED, WOKING AND LONDON